POWER

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Success is Self-Motivated

A SUCCESSFUL industrialist, talking about the capabilities of men, especially their power of initiative, their willingness to assume responsibility, their ability to go to it "on their own," remarked:

"Nobody ever succeeded because somebody wanted him to succeed."

One may get inspiration, suggestion, encouragement from others, but no matter how hard and persistently somebody else steps on the gas, he never will get started so long as the tank is empty.

Advice, direction and good wishes may give him a running start, but he will not hold out and get anywhere until he sees that the old boat is ready for the road and stocked for the trip; until he takes the wheel himself, with his goal definitely in mind, a good idea of the road and fixed determination to get there.

Few will be interested in and glory at his success. More will envy and decry him if he succeeds and roll rocks in his way rather than smooth his path.

Progress is relative. Many resent being passed in the scramble for wealth, for office, for preferment and public approval.

It is not because they want him to that anybody succeeds.

A man full of pep and ambition and appreciation of the possibilities comes into the power department of an ancient industry.

There is a great opportunity for somebody to win a goal by putting that plant upon its feet.

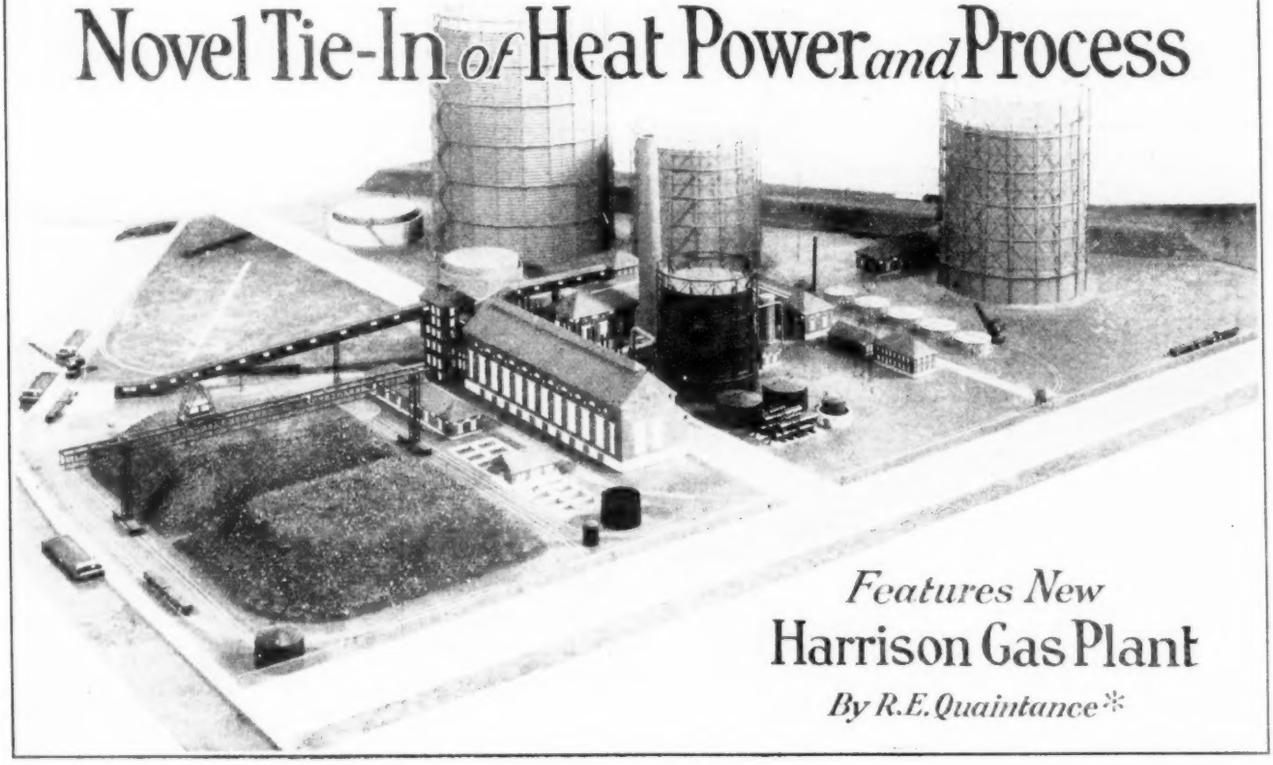
Do you think he could do it because the men who have been there for years and have not done it want him to succeed?

Even the management and proprietors are prone to resent interference instead of welcoming interested endeavor for improvement.

If he succeeds, it will be by reason of self-confidence and resourcefulness that will overcome the inertia and indifference that have let the plant run down, and the jealousy and resentment of those who have not had the interest and ability to keep it up to date.

F. R. Low

Novel Tie-In of Heat Power and Process Features New Harrison Gas Plant



By R.E. Quaintance*

THE recent completion in Harrison, N. J., of a large water-gas plant embodying in its design many unusual features is an event of interest not only to gas engineers, but also to all those concerned with the production of steam and power, and the maximum recovery of heat in the fuel burned by suitable control devices, and the intelligent use of exhaust and bled steam, waste-heat boilers, steam accumulators, etc.

This plant exemplifies an industrial revolution now in progress, which may soon make it impossible to look upon the power plant as a separate entity in manufacturing establishments in which the processes consume large quantities of fuel as well as steam and hot water. The power plant, as such, can hardly be located, or even defined in the Harrison Gas Works. There is a fuel-burning boiler room, but this has its counterpart in the row of waste-heat boilers in the gas-generator house. Practically no electrical power is generated except when it is necessary to throw in a small stand-by turbine-generator set. Yet, mechanical power, using the term in its broad sense, is generated in large quantities by turbine-driven blowers, exhausters, compressors and steam-driven auxiliaries. These are scattered all over the works.

The waste-heat boilers constitute one tie between the boiler room proper and the process work. Another tie is the exhaust steam from all auxiliary units which, entering a steam accumulator, along with steam bled from the compressor turbines, eventually serves for the water-gas run of the generators. Other interesting features are the combined coal and ash handling systems for gas-making and steam-making fuel.

While the installed capacity of the plant is 30,800,000 cu.ft. of carbureted water gas daily, provision has been made throughout for adding units for an ultimate capacity of 46,200,000 cu.ft.

The plant, which was designed and constructed by the Public Service Production Company, an engineering organization associated with Public Service Corporation of New Jersey, is located on the Passaic River. It is equipped with the most modern liquid purification apparatus.

Without going into details of gas manufacturing technique, it is worth noting that the main gas holder is of the new "waterless" type and of 15,000,000

WITH an installed capacity of 30,800,000 cu.ft. of carbureted water gas daily, the recently completed Harrison Gas Works of the Public Service Corporation (New Jersey) is of considerable size, but it is noteworthy rather because of engineering features that mark a step forward in economical gas manufacture. The whole layout has been considered as a unit, and the production and consumption of power and heat have been tied in with process work to achieve a maximum utilization of the fuel used. Some features of particular interest to power engineers are: Automatic combustion control; steam accumulators; waste-heat boilers; turbine-driven compressors, blowers and exhausters with utilization of steam bled from the compressor turbines and exhaust from other apparatus.

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cu.ft. capacity, a size equal to the largest in operation or under construction in the world.

The present boiler house contains four 6,150-sq.ft. cross-drum, horizontal boilers. These are built to operate at 240 lb. gage pressure at 300 per cent of rating, with superheaters to yield 100 deg. superheat at normal rating, when the operating pressure is 225 lb. at the superheater outlet.

The setting height is 14 ft., and the fuel is burned on traveling-grate stokers that will develop 275 per cent of boiler rating with either coke breeze or anthracite. The stokers are fed by traveling larries. By the use of these larries a central coal tower is permitted. This is in the center of the ultimate boiler house, so that an unusually light boiler room is obtainable. The bunker itself has a division wall, permitting the storage of coal and coke breeze separately, and they are so fed to the boilers, avoiding unsatisfactory fires obtained with imperfect mixtures of these fuels.

The air supply to these stokers is furnished by three 60,000-cu.ft.-per-min. forced-draft fans with turbine drives.

Three boiler-feed pumps, one of which can supply two boilers at full overload, are installed, and under ordinary conditions two pumps will carry the four works boilers and eight waste-heat boilers, leaving the remaining pump as a spare. These pumps take suction from an open-type metering feed-water heater, where the water is heated to approximately 210 deg. The local city water is used for boiler-feed purposes after passing through zeolite feed-water softeners that have a capacity of 11,250 gal. per hour. Feed-water regulators control the water supply to each waste-heat boiler as well as to the works boilers.

To dispose of the ashes from the boiler plant, a sluicing system is installed. The stokers dump directly into hoppers open to a trough below. Salt water, used in the gas condensers, will be returned to the boiler house to sluice the ashes through the trough to an open pit.

One of the standard systems of automatic combustion control, actuated by compressed air and oil, has been installed in the boiler house. The master controller is mounted on a gage board along with four steam-flow air-flow meters, recording feed-temperature thermometers and recording pressure gage.

All boiler-room auxiliaries are steam driven, turbine drive being used for feed and service pumps and forced-draft fans. The steam drives were chosen after due consideration of electric drive, the need for process steam being a determining factor in the final choice. Individual engine drives were selected for the stokers because they made possible an extremely flexible and simple speed control at low cost.

The chief demand for high-pressure steam comes from the turbine-driven gas compressors. High-pressure steam is also required for turbine-driven gas blowers and exhausters, gas-plant auxiliaries, and a 400-kva. turbine generator installed for emergency use. Only a small amount of electrical energy, chiefly for lighting and fuel handling, is required by the plant, and this is normally supplied through a connection with the Public Service electric distribution system.

As may be seen by a study of the steam-flow diagram (Fig. 6), the power has been ingeniously tied in with gas-manufacturing processes in such a way as to achieve a maximum utilization of the fuel burned in boiler furnaces and gas generators.

For example, steam for the water-gas run of these generators is supplied by the exhaust of steam-driven auxiliaries, supplemented, as far as necessary, by steam

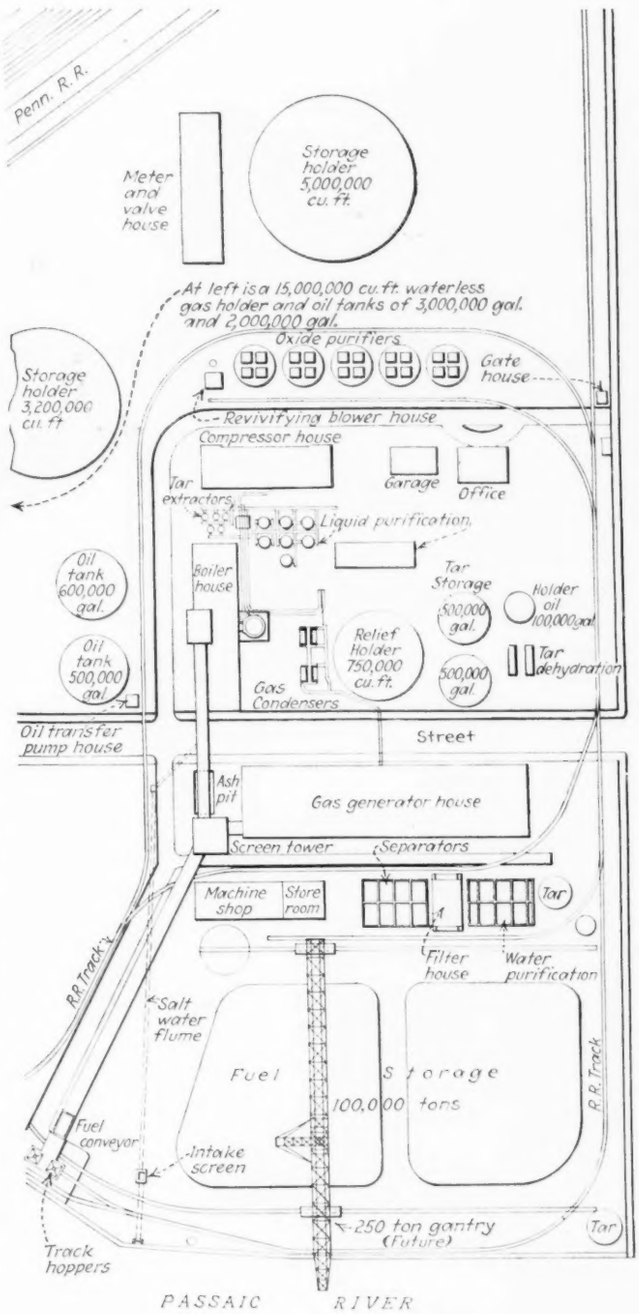


Fig. 1—Layout of gas plant

Principal power and steam equipment is in boiler house, compressor house and generator house.

bled after the first stage of the compressor turbines. Fluctuations are taken up by two steam accumulators installed between the low-pressure steam supply and the generators. During the blow high-pressure steam is produced by waste-heat boilers on the generators.

A separate building houses the turbine gas compressors and exhausters with their auxiliaries. This building contains four compressors for gas distribution and

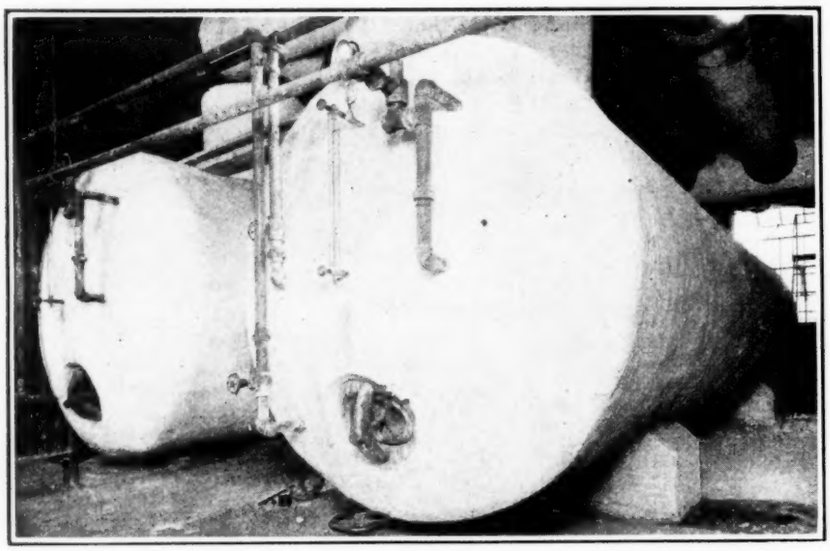


Fig. 2 (Left) — The two steam accumulators take exhaust and bled steam and discharge to the water-gas generators

Fig. 3 (Right)—Automatic control for the steam accumulators

When the accumulator pressure falls below 7½ lb., the regulators admit bled steam and then live steam.

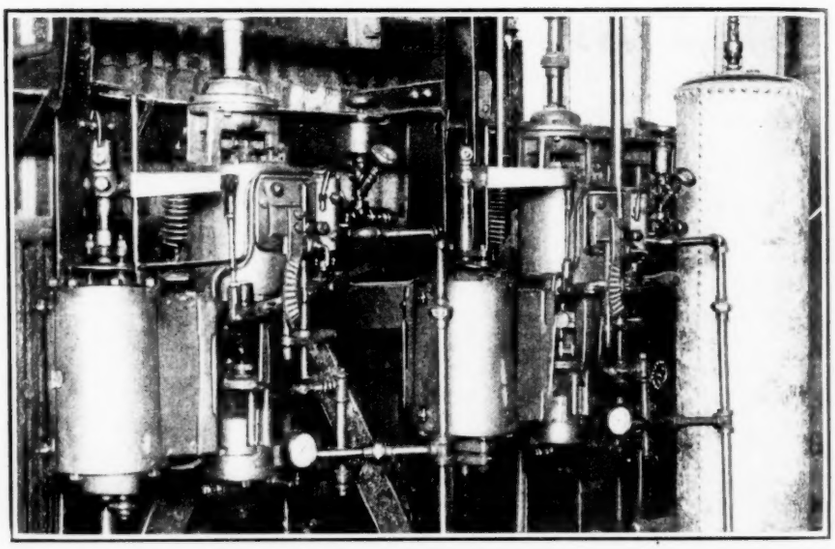
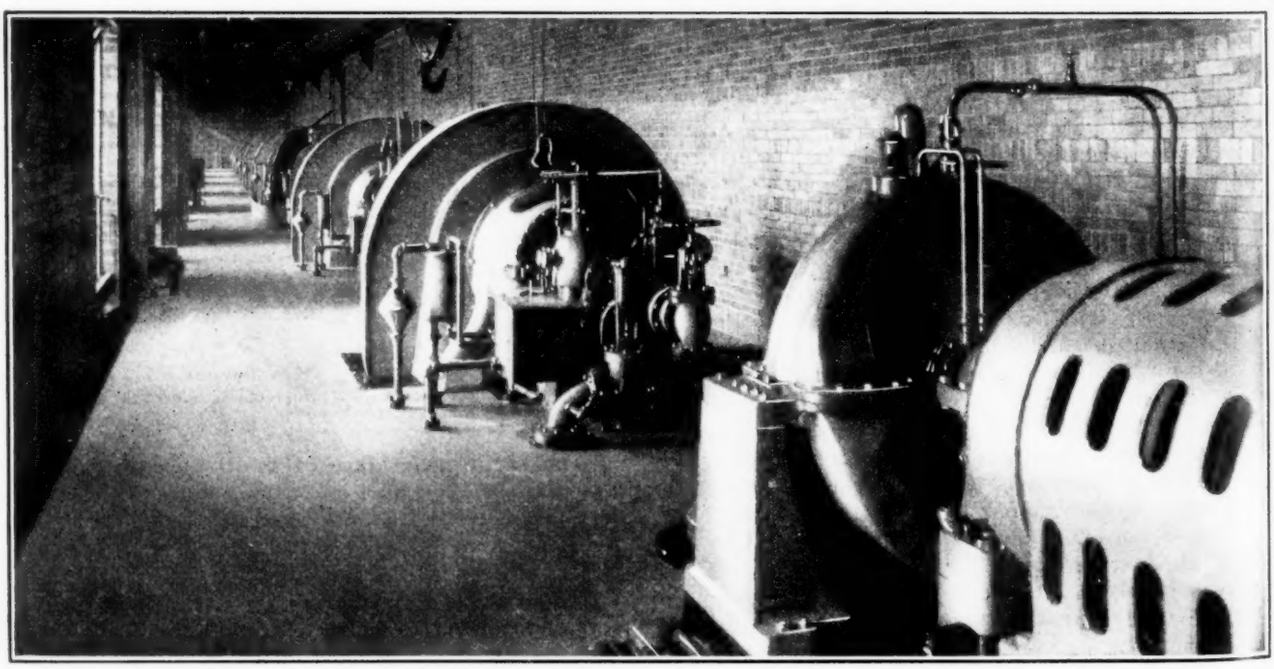


Fig. 4 (Below)—This half of the gas generator house now contains eight turbine-driven gas blowers and one 400-kva. turbine generator



three gas exhausters. In the basement are the condensers, pumps and piping headers. For the complete plant this building will be extended to house six compressors and four exhausters.

These machines are the latest development in centrifugal gas-pumping machinery, and their operation will doubtless excite considerable interest in the gas industry. They are of 25,000 cu.ft. per min. capacity at 15 lb. gas pressure. Compression is effected in five stages with the use of impellers of the single-inlet type, shrouded. The inter-stage diaphragms are provided with water jackets for cooling the gas during compression and between stages.

Each compressor will operate over a speed range of 3,500 to 4,300 r.p.m. and is driven by a three-stage Curtis automatic extraction condensing steam turbine, rated 1,037/1,740 hp. (corresponding to blower rating) with a maximum turbine rating of 2,500 horsepower.

These turbines are provided with suitable openings and valve mechanism to permit automatic extraction of steam from the first stage, at pressures ranging from 10 lb. to 20 lb. gage, depending on the setting.

When boosting 25,000 cu.ft. per min. of gas at 15 lb. gage pressure, 45,700 lb. of steam per hour may be extracted at 15 lb. pressure with a total steam flow to the throttle of 47,300 lb. per hour.

Each of these large turbines is served by a low level, multi-jet condenser to produce a vacuum on the machine of 28 in. (30 in. barometer) with a steam flow of 18,500 lb. per hour, which is the flow at full load with zero extraction.

The condensing water is supplied by centrifugal turbine-driven pumps in the boiler house adjacent. These take suction from a 48-in. intake flume providing, by gravity flow, salt water from the Passaic River.

The exhausters, of which three are now installed, are of the centrifugal type with single-inlet impellers mounted on an extension of the turbine shaft, so that there will be but two bearings for the entire machine. These exhausters are rated at 14,400 cu.ft. per min. at 3.45/3.8 lb. equivalent standard air pressure, and will be driven at 4,400/4,650 r.p.m. by a 175-hp. single-stage Curtis non-condensing steam turbine.

In connection with the eight water-gas generators there are installed the same number of vertical waste-heat boilers. These are 7 ft. 6 in. in diameter with 4-in. tubes 22 ft. long and designed for a steam working pressure of 240 lb. per sq.in. The total heating surface is approximately 4,080 sq.ft. per boiler.

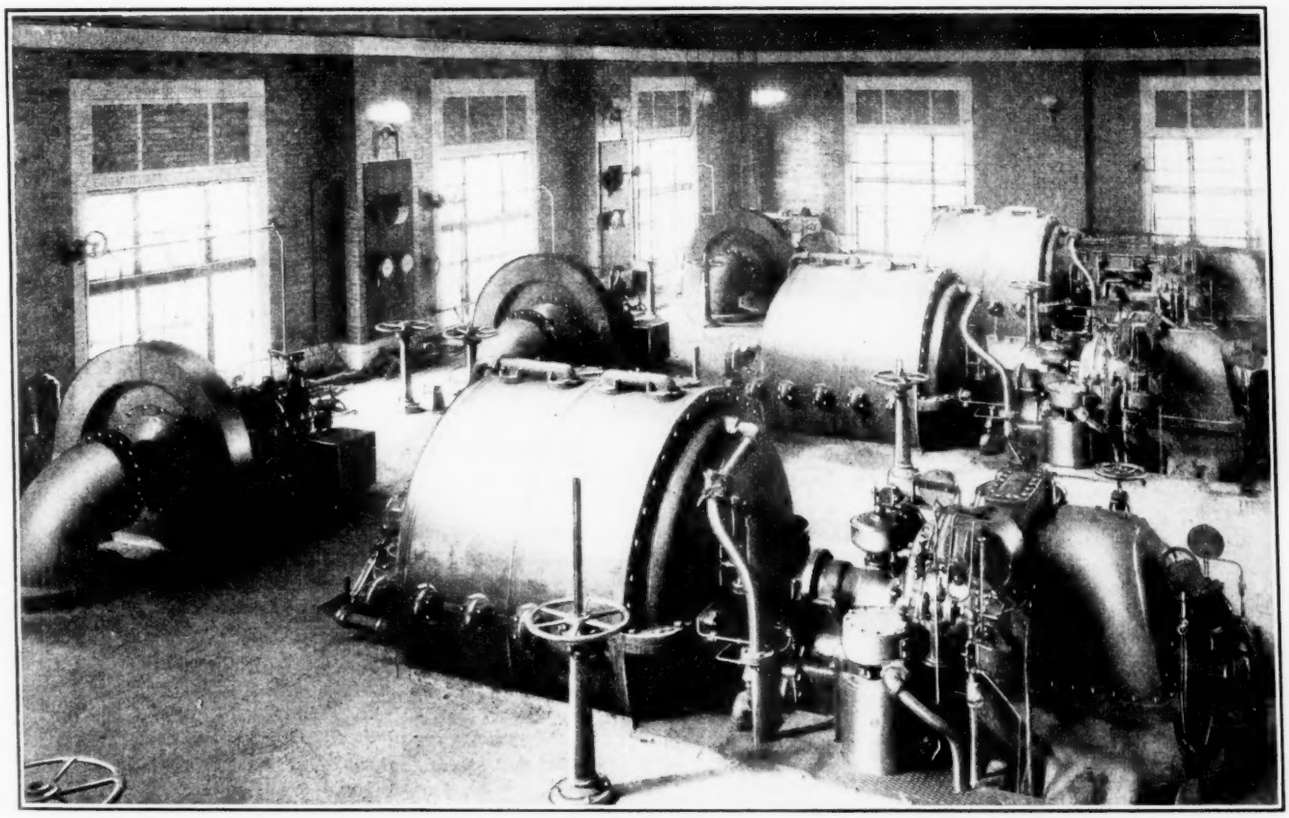


Fig. 5—Each of the four turbine-driven gas compressors (right) can compress 25,000 cu.ft. of gas per minute to 15 lb. gage pressure. On the left are three gas exhausters

Each gas-generator will be served by a turbine-driven centrifugal blower of 22,000 cu.ft. per min. capacity at 42 in. water pressure. These machines have two bearings, the turbine shaft being extended to carry the impeller, which is of the double-inlet type. The compressor, running at a speed range from 3,450 to 3,890 r.p.m., is direct-connected to a 199-250-hp. single-stage Curtis non-condensing steam turbine.

For more efficient utilization of the exhaust steam from the turbine-driven auxiliaries throughout the plant and for a maintenance of a constant pressure on the low-pressure loop feeding the water gas generators, two steam accumulators are installed. These are 8 ft. in diameter and 30 ft. long.

Each accumulator is designed to store 900 lb. of

steam between a maximum pressure of 15 lb. and a minimum of 7½ lb. per sq.in. gage. The whole system is capable of passing steam to the low-pressure loop at the rate of 125,000 lb. per hour.

The piping arrangement provides for an inlet manifold to the two accumulators, into which is introduced the exhaust steam from the auxiliaries, the bleeder connection from the extraction turbines and a high-pressure steam connection. The exhaust steam flow is not restricted, but the bleeder and high-pressure lines have balanced valves operated by the regulator.

The outlets of the two accumulators are provided with a 24-in. discharge manifold, which is fitted with a balanced regulating valve controlling the output from the accumulators.

The regulator operates to control the flow of steam from the accumulator to the low-pressure loop feeding the gas generators, holding the bleeder valve and the high-pressure valve closed until the butterfly valve is wide open and the pressure of the accumulator is brought down to the minimum. A further demand for low-pressure steam will cause the regulator to open first the bleeder valve and then (if necessary) the high-pressure valve, admitting a sufficient amount of bleeder and high-pressure steam to maintain the pressure to the generators at the minimum amount.

A decrease in demand or an increase in exhaust-steam supply will cause the high-pressure valve to close first, then the bleeder valve, pressure in the accumulator building up and storing steam in the water until the limiting pressure has been reached. This pressure is determined by the setting of the relief valve.

Any further increase in supply of low-pressure steam will escape to atmosphere through the relief valve.

This system gives a supply of low-pressure steam at constant pressure, and by storage in the accumulator the consumption of high-pressure steam is reduced to a minimum and the exhaust steam obtained during the blow is stored for use during the run.

On account of the large quantities of fuel required for the water-gas generators, fuel for the boiler house is handled by the same system. The capacity of the present fuel-handling system as designed by the Public Service Production Company is 1,000 tons of run-of-mine coal or 700 tons of coke in an 8-hour day.

At present five 30-in. conveyor belts, one screen station and two car hoppers are installed. Coal is charged into hoppers at the dock from railroad cars or, for the present, by locomotive cranes, from barges. It is discharged by special feeders onto either or both of the two main belts, which are 420 ft. long and rise at an angle of 13 degrees.

These belts terminate in the screening tower which is located to the west of the generator house. Here, by means of a rotary grizzly and vibrating screen, coke ¾ in. and larger is fed to the generator house belt and the screenings under ¾ in. to either of two belt conveyors feeding the boiler-house bunker. Or at the same time coal may be fed to the screening tower and through a crusher or not, as required, is fed to the boiler house.

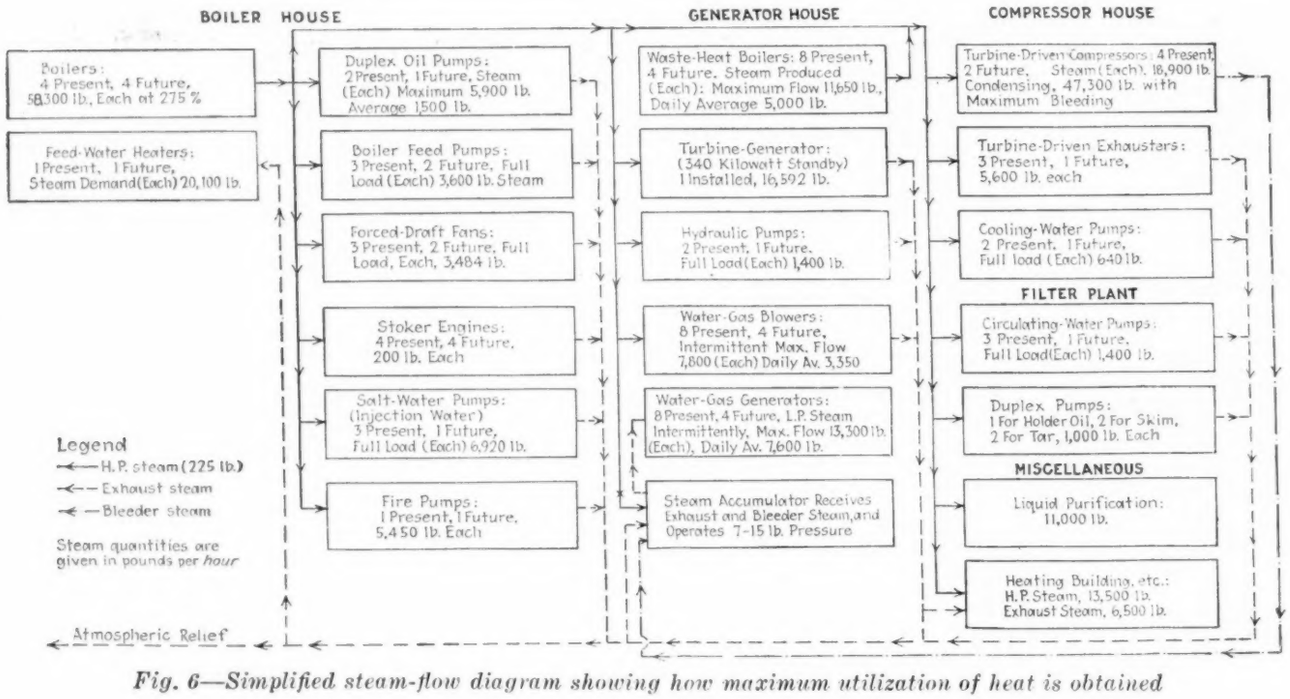

BOILER HOUSE
GENERATOR HOUSE
COMPRESSOR HOUSE
Boilers: 4 Present, 4 Future, 58,300 lb. Each at 275 %
Feed-Water Heaters: 1 Present, 1 Future, Steam Demand (Each) 20,100 lb.
Duplex Oil Pumps: 2 Present, 1 Future, Steam (Each) Maximum 5,900 lb. Average 1,500 lb.
Boiler Feed Pumps: 3 Present, 2 Future, Full Load (Each) 3,600 lb. Steam
Forced-Draft Fans: 3 Present, 2 Future, Full Load, Each, 3,484 lb.
Stoker Engines: 4 Present, 4 Future, 200 lb. Each
Salt-Water Pumps: (Injection Water) 3 Present, 1 Future, Full Load (Each) 6,920 lb.
Fire Pumps: 1 Present, 1 Future, 5,450 lb. Each
Waste-Heat Boilers: 8 Present, 4 Future. Steam Produced (Each): Maximum Flow 11,650 lb., Daily Average 5,000 lb.
Turbine-Generator: (340 Kilowatt Standby) 1 Installed, 16,592 lb.
Hydraulic Pumps: 2 Present, 1 Future, Full Load (Each) 1,400 lb.
Water-Gas Blowers: 8 Present, 4 Future, Intermittent Max. Flow 7,800 (Each) Daily Av. 3,350
Water-Gas Generators: 8 Present, 4 Future, L.P. Steam Intermittently, Max. Flow 13,300 lb. (Each), Daily Av. 7,600 lb.
Steam Accumulator Receives Exhaust and Bleeder Steam, and Operates 7-15 lb. Pressure
Turbine-Driven Compressors: 4 Present, 2 Future, Steam (Each), 18,900 lb. Condensing, 47,300 lb. with Maximum Bleeding
Turbine-Driven Exhausters: 3 Present, 1 Future, 5,600 lb. each
Cooling-Water Pumps: 2 Present, 1 Future, Full load (Each) 640 lb.
FILTER PLANT
Circulating-Water Pumps: 3 Present, 1 Future, Full Load (Each) 1,400 lb.
Duplex Pumps: 1 For Holder Oil, 2 For Skim, 2 For Tar, 1,000 lb. Each
MISCELLANEOUS
Liquid Purification: 11,000 lb.
Heating Building, etc.: H.P. Steam, 13,500 lb. Exhaust Steam, 6,500 lb.
Legend
H.P. steam (225 lb.)
Exhaust steam
Bleeder steam
Steam quantities are given in pounds per hour
Atmospheric Relief

Fig. 6—Simplified steam-flow diagram showing how maximum utilization of heat is obtained

The main feeder belts are duplicated side by side to permit such a service of two different fuels to two different receiving bunkers at one time, as well as to obtain the continuity of operation secured by a duplicate installation. The total fuel-handling system requires 3,560 ft. of 30-in. belting.

Energy for the electrically driven equipment is supplied by the Public Service Electric & Gas Company at 2,400-volt two-phase. At the plant substation, located in the screening tower, it is stepped down through two 200-kva. transformers to 440-volt three-phase for auxiliary power and 220/110-volt single-phase for lighting. The general distribution system for the plant is all underground in conduits.

The only auxiliaries of size that are electrically driven are the fuel-handling motors, which are totally inclosed and arranged for full voltage starting with centrally located control equipment.

Engineers as Pinch-Hitters

By C. E. COLBORN*

AMONG the many terms that have been applied to operating engineers, there stands out in the writer's memory, one in particular which, although non-committal in meaning, has a world of hidden truth in it, namely, "Pinch Hitters."

Operating engineers are all pinch-hitters. The work follows usually a monotonous course, day in and day out, and only average exertion is required in the performance of the duties. But an emergency arises. Immediately they must respond, and produce the hit, not 50 per cent of the time, as do the pinch-hitters of sport, but every time, and without delay. They must act to set aright the deranged apparatus and bring operation back to normal.

A certain power plant in the hills of West Virginia was running along with a peak load of around 20,000 kw. Everything was in its usual good operating condition, and no one was particularly on the alert for trouble. The plant contained four boilers, two turbine - generators and three boiler - feed pumps as essential units. Two of the pumps were out of service for the day, one being dismantled, the other having its turbine-drive steam supply line disconnected. The third pump, which was in operation, had been recently overhauled and was thought to be in first-class condition. Noon came and, as the load fell off, everyone eased off for lunch, the superintendent going to his home, a short distance away. Suddenly the feed pressure fell off, the feed pump slowed down and stopped and the water level in the boilers started for the grate bars. Here was a real emergency. A hurried examination indicated that the throttle valve disk had dropped off on the turbine driving the boiler-feed pump, steam pressure at once closing the valve.

OPERATING ENGINEERS are pinch hitters. Their salaries are out of proportion to their physical exertions; their jobs are soft and secure, so to speak; they are shielded from the extremes of the weather and from the rise and fall of the business tides; but when trouble comes, then it is up to them to step in and fill the breach 100 per cent. Their worth to their employers may be judged entirely by their ability in such cases. An hour's interruption may cost the company more money than can be pared off the coal bill in a year's hard labor.

A hurried call brought the superintendent. The valve was jerked open, the disk secured and replaced properly on the valve stem and the valve reassembled. This done, the pump was re-started. Meanwhile, the boiler firedoors had been opened wide, the dampers were open to the limit to cool off the boilers and the main turbines turning over unloaded and at reduced speed.

This whole operation consumed about twenty minutes, all of which time the water was out of sight in the boilers. The pump being restarted, water was slowly fed back to the boilers, the steam pressure picked up and before one o'clock the plant was carrying its load.

Here is the chief's analysis of the situation and his movements as related some time afterward to the writer: If the turbine driving the pump was stopped, it had to be started, which meant that the throttle valve must be repaired. Meanwhile, to conserve all possible water in the boilers, they must be kept from popping. Therefore the two main turbines were allowed to operate at no load, putting a small demand on the boilers. The boilers had considerable water stored in them, and by cooling down the fires to the limit, the pressure was dropped to a safe point in short order. No tubes leaked, and when the pump was again ready for operation there was but one thing to be done, namely, water must be put back in the boilers. A plentiful supply of this was available owing to the continued operation of the turbines and condenser pumps, which were steam driven, and the feed valves were opened very slowly. Everything held and a 24-hour prospective shutdown was reduced to a 20 - minute interruption. The other course of action—to trip everything out of service and rely on the steam service pumps to supply enough water, as the steam pressure failed, to permit quenching the fires—could have resulted only in a large number of burned tubes, for it takes a lot of water to put out the fire on the stokers of four boilers of this size. The loss of even one boiler in this manner would have cost the company more money than the superintendent could pare off his operating costs in a good many years.

It is in the ability to recognize the chance, analyze and decide quickly, that the operating engineer serves his destiny.

Another plant, of 50,000 kw. capacity, operating in parallel with a large system, had been running at reduced capacity over a light week-end load period. The second unit was being warmed up and prepared for putting in service. It was about 5:30 a.m. The chief had just come into the control room, and walking around to the frequency recorder he tried to focus his tired eyes on its chart. Suddenly, "the bottom dropped out of the frequency," the pen started down, down, slowly at first, then faster toward the zero. Here was an emergency in which something had to be done and at once, if the system operation was to be saved.

In a station of this size the whole operating crew must be of the pinch-hitter sort. The situation was quickly handled as follows: The turbine was operating at about one-quarter normal speed. The turbine operator opened the throttle wide, brought the machine quickly to speed, and the control room synchronized as the speed came up, catching the light and closing the main switch on the fly at about three-quarters speed.

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The reserve capacity of this machine restored the system frequency to normal and saved a disastrous shutdown. A generator at one of the other stations had gone bad.

Questionable operation this was, it is true, but in an emergency something must be done, and it is the man or crew who does that thing and succeeds who warrant the name, engineers.

Another station on this system, after a long and useful life, was being carried as a stand-by under banked boilers and with turbines warm but not rotating. It was in this condition one Sunday afternoon when a transformer blew up in one of the other plants.

Two 10,000-sq.ft. Stirling boilers with economizers, had been banked for 36 hours and steam was at about half normal pressure. A skeleton crew was available. In twenty minutes this crew had a 20,000-kw. turbine on the line and carrying load.

The water stored in the boilers and economizers had heat enough in it to furnish steam sufficient to start the turbine rolling and bring it up to speed. At once, its power was available for stoker drives and induced-draft fans and other auxiliaries and the station was on the line. But in this emergency the pinch hitter didn't come through successfully. Loss of power on the auxiliary bus tripped the 20,000-kw. unit from the line. This was an old unit having a vacuum breaker mounted on the turbine exhaust casing, and operated by the governor trip so as to open automatically in case the throttle closed, breaking the vacuum and slowing down the turbine. It was equipped with a hand and a pneumatic reset. Through some trouble the pneumatic reset stuck in the open position, and consequently the valve would not stay closed.

Instead of closing the vacuum breaker by hand and blocking it shut, about fifteen minutes were consumed in attempts to make the pneumatic trip mechanism function, and as a result a possible three-minute interruption was stretched into a twenty-five minute shutdown. The pinch hitter had struck out.

Film Evaporation in Boilers

FILM evaporation is not a new idea in engineering practice. It has been used for years in certain ammonia condensers which are frequently placed on the roofs of ice plants. Water is allowed to drip in a thin film over the tubes, which are exposed freely to the air. The resultant evaporation of the warm water, in humidifying the passing air, provides the cooling necessary to condense the ammonia. Similar evaporative surface condensers have been used at times to condense exhaust steam.

Another application of film evaporation is in certain types of evaporators that supply pure distilled water for boiler-feed makeup or for other purposes. The water in the evaporator is recirculated by a small pump and is discharged in a thin stream over the coils or pipes containing the heating steam. An advantage claimed for this form of evaporator over the standard submerged type, is that the circulation of the water by the pump is positive, while in the submerged type of evaporator circulation depends on convection currents set up by small temperature differences and hence is not very active. In the film type the whole temperature head can be applied to evaporation, and film evaporators will therefore operate on lower temperature differences than the submerged type.

A new form of boiler has recently been announced which is based on the use of film evaporation inside the tubes. The tubes are nearly vertical. The circulating water is delivered by a small circulating pump at a pressure slightly above boiler pressure to the upper header, to which the tubes are joined. The water enters through a small orifice in each tube, so that the tubes are not completely filled with water. The water in the form of a thin film runs down the inside of the tube at a relatively high velocity due to gravity. The tubes used are small, being about three-quarters of an inch in diameter, and about twenty-five feet long. They are spaced wider at the bottom than at the top to allow for the decrease in gas volume and to maintain high gas velocities.

It is claimed for this form of boiler that the positive circulation and lack of a head of water on the tubes permits greater heat transfer as in the film evaporator. The steam bubbles, as rapidly as formed, are swept into the center of the tubes. The descending stream of water sticks to the heated wall of the tube. Hence all heating surface is effective and is not blanketed off at intervals by the formation of steam bubbles. High gas velocities are also maintained to increase the rate of heat transfer. It is also claimed that this rapid circulation will not permit scale to accumulate and form solid coatings on the inside tube surface due to high water velocities.

Such construction presents some new ideas in boiler design. The use of high water and steam velocities and small tubes all tend toward rapid and efficient heat transfer. Successful performance depends on three factors: The continued operation of the circulating pump; no scale formation on the tube surfaces, and the freedom from stoppage of the orifices at the top of the tubes. In waste-heat work with moderate gas temperatures these may not be serious factors. On the other hand, tubes exposed to furnaces with direct radiant heat absorption must be supplied with water at all times if failure would be avoided, and even thin scale formations cannot be tolerated. Several such boilers have been built for waste-heat work.

THE POWER COMPANIES ARE REALIZING, with the increased cost of coal, that there is another factor to be considered in addition to the load factor, the power factor, the diversity factor, the factor of safety, etc.—and that is the heat factor. For every unit of electricity delivered to the customer, be it a factory or dwelling, the equivalent of some six units is being thrown away, and not only thrown away, but costing enormous sums of money in the provision of circulating water to enable this waste to be disposed of. Public institutions and factories are fast awakening to the value of the heat factor.—*John H. Barker*, in *Engineering*.

IN SELECTING A FAN FOR HIGH ALTITUDES, the density of the air must be taken into account. The static pressure developed by a fan at any given speed will decrease with increased altitude, and it is therefore necessary to make a correction, as fan performances are based on sea-level conditions.

Operation and Adjustment of Automatic Load Regulators for Electric Generators

By F. A. BYLES
Flow-Meter Regulator Engineering Department, General Electric Company

FREQUENTLY, conditions arise where it becomes desirable to maintain the load constant on an electric generator or other equipment. This article describes the operation of two different types of regulators for doing this and explains how these equipments are put into service and adjusted.

AMONG the many exacting conditions attendant upon modern electrical installations the problem of load regulation of alternating-current circuits is frequently met. Of the various conditions under which it may be desirable to control the load the most common are:

1. To hold constant load for a special process.
2. To maintain constant full-load output from an electric steam boiler, steam turbine or hydroelectric unit.
3. To regulate the load, when a portion of the required current is purchased on a maximum demand basis, so that the purchased portion does not exceed a given maximum demand and at the same time is kept close to that value in order to take full advantage of a given contract rate.

One form of automatic load regulator is that known as the current-control type, which is comparatively simple in construction and gives satisfactory load regulation when the voltage and power factor remain fairly constant. Another form is the wattmeter type, which is used for circuits where the voltage and power factor vary and where it is desired to hold a given true-watt load. Both of the types are described, and either can be applied to single or polyphase circuits. The current-control type, however, is usually restricted to single-phase and balanced two- and three-phase circuits.

Current-Control Type Regulator

Fig. 2 shows a load regulator of the current-control type, the elementary scheme of connections being shown by Fig. 1. The magnetic core *P* is suspended in solenoid *M* from the end of lever *B*, which is brought to a balanced position when in normal operation by means of spring *S*. Solenoid *M* is excited from the current transformer and is paralleled by the adjusting rheostat *R*. By decreasing the resistance of rheostat *R*, a higher current will be required to cause lever *B* to come to a balanced position and vice versa. When in a balanced position the contact bar carried by lever *B* does not make contact with either the lower or the upper stationary contact. The dashpot *D* provides damping for the movement of core *P* in order that contact will not be made for current changes which are of but momentary duration. The control motor *CM* which drives the load-regulating mechanism is provided with two field windings excited through the load-regulator contacts. The upper contacts, which are closed when the load falls below normal, actuate winding *A*, which causes the motor to operate the load-regulating mechanism so as to increase the load. The lower contacts close when the load rises above normal and excite winding *L*, which reverses the motor rotation and causes the load to decrease. The motor *CM* is usually connected through the necessary gearing to either a field rheostat or the turbine valve gear, depending upon the type of unit to be regulated.

For example, assuming that it is desired to hold constant the output of a turbine-driven alternating-current generator, and assuming that the current desired is 1,000 amperes and that the normal operating current for solenoid *M* is one ampere, the use of a standard current transformer having a 5-ampere secondary winding means that a 200:1 ratio will be used, and an adjusting rheostat *R* selected which will shunt 4 amperes of the secondary current at full load. Further, it may be that spring *S* has been so adjusted that the center movable contact just comes to a balance between the two stationary contracts at 1,000 amperes and that both of these stationary contacts have been adjusted so that contact will be made on either the upper or lower side with an increase or decrease in current of 2 per cent. Now, if the current rises to 1,020 amperes, the lower contacts will close, energizing the motor-field winding

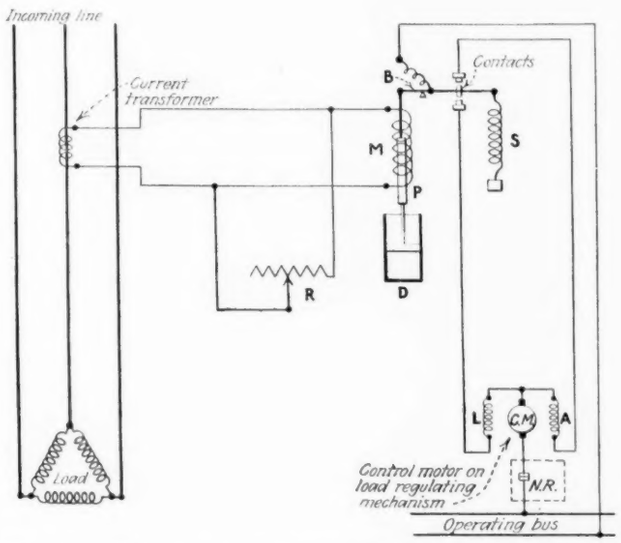


Fig. 1—Elementary connection diagram for current-control type load regulator

L and causing the motor to operate the turbine valve gear so as to reduce the load until the lower contacts open. The same action takes place when the load falls 2 per cent below normal except that the upper contacts close energizing field winding A and cause the motor to operate the valve gear in the opposite direction to raise the load.

If it is desired to reduce the load, it is necessary to turn rheostat R to cut in more resistance, which causes an increase of current in solenoid M, in turn causing the contact mechanism to reduce the load until the former one-ampere balance has been re-established.

An important point to be remembered in connection with a current regulator of this type is that the normal balanced current in the solenoid always remains the same, the current through the adjusting rheostat changing to agree with the various load positions.

In cases where very rapid action of the load regulating mechanism is obtained, the load may overshoot the desired normal value unless a notching relay is used. This relay, shown at NR, Fig. 1, is usually connected in series with the motor CM. The contacts are actuated by a small cam operated by a synchronous motor, which opens and closes them momentarily several times each minute until the load is re-established. Fig. 3 shows a notching relay of this type. Adjustments are provided so that the period of contact making may be increased or decreased as found necessary to suit the requirements of a given installation.

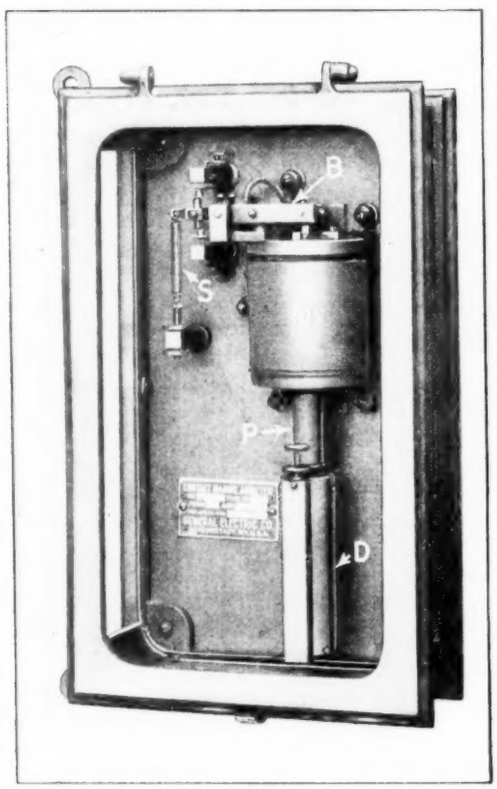
Wattmeter-Type Load Regulator

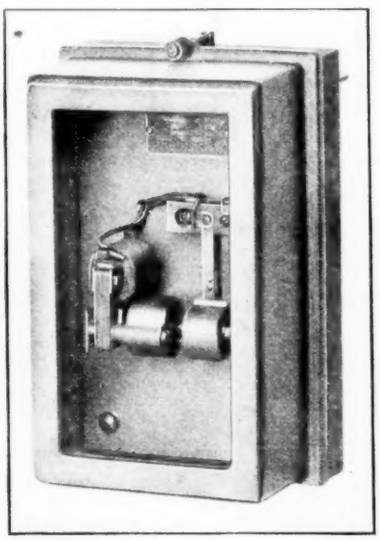
A load regulator of the wattmeter type is shown with its control panel in Fig. 4 and an elementary diagram of connections in Fig. 5. For the sake of simplicity, switches and contactors have been omitted from the diagram. With reference to this diagram the two potential coils P are carried on the movable shaft S and are connected through flexible springs F to the potential transformers PT through external resistances A and B.

The current coils C, which are connected to current transformer CT, are stationary and arranged at right angles to and outside of the potential coils P. The potential element is suspended from the top supporting bracket by a fine steel music wire R and is held in a central position and guided at the bottom by a ring stone jewel bearing T. Two opposing spiral springs, one of which is mounted at each end of the shaft, provide tortional resistance opposing the torque of the potential element.

The lever arm and contact holder D is attached to the upper end of the shaft S. The contact mechanism, when in the regulator, is turned 90 deg. from the position shown in the figure, so that contact arm D can be rotated with the shaft S. The amount of movement of shaft S is very small, being just sufficient to bring contacts G or H in contact with cam U. When in operation the vertical contact cam U is rotated between contacts G and H by means of a small series motor M, which is connected through the reducing gears J. When the load rises above or falls below the normal predetermined amount, the change in torque causes arm D to swing to the right or left and allows either contact G or H to make contact with this rotating cam. This contact is intermittently closed and opened by the action of the cam until conditions are restored to normal in the outside circuit. Rheostat RH provides a means for changing the speed of contact rotation to suit the requirements of the circuit.

Holding magnets V_1 and V_2 are provided for improving the contact action. Magnet V_1 is operated with contact H and magnet V_2 with contact G; that is, when





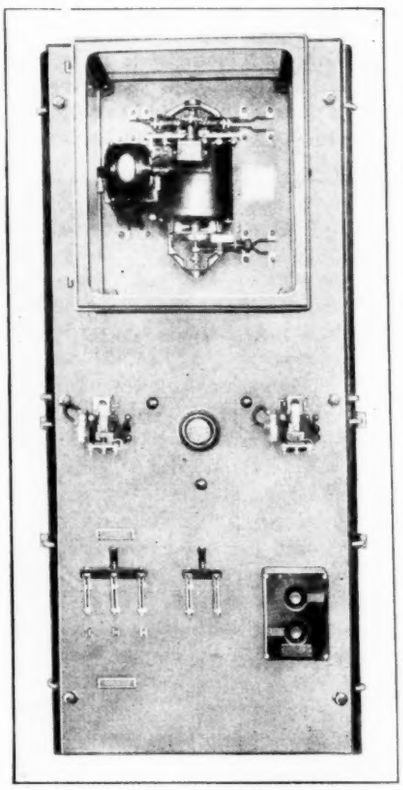


Fig. 2 (Left)—Current-control type load regulator

Fig. 3 (Above)—Notching relay

Fig. 4 (Right) — Wattmeter-type automatic load regulator

contact H touches the center contact cam, connection is made to magnet V_1 which attracts armature Z_1 and holds H in solid contact with the cam until the cam break takes place and vice versa. The involute form of contact cam provides a means for changing the time of contact making in proportion to the load which has to be corrected. The holding effect of the magnets V_1 and V_2 may be changed by turning the core screws in or out as desired. Load adjustment is obtained by means of adjusting screw LJ.

The motor M_2, if small, is operated directly from the regulator contacts, but normally a contactor is interposed in each side of the circuit. This motor is connected to the load raising and lowering mechanism. In the case of a turbine-generator the motor operates the valve gear of the turbine while, with an electric steam boiler, the water intake valve would be controlled by it. It will be seen, that the control motor M_2 may be applied in many ways, depending on the apparatus that is to be regulated. The internal connections of the equipment are the same as used for standard curve-drawing wattmeters for either two or three-phase circuits.

Current and Potential Transformers

Current transformers are selected with five-ampere secondary windings at full load. The potential transformers are usually of 200 volt-ampere capacity with

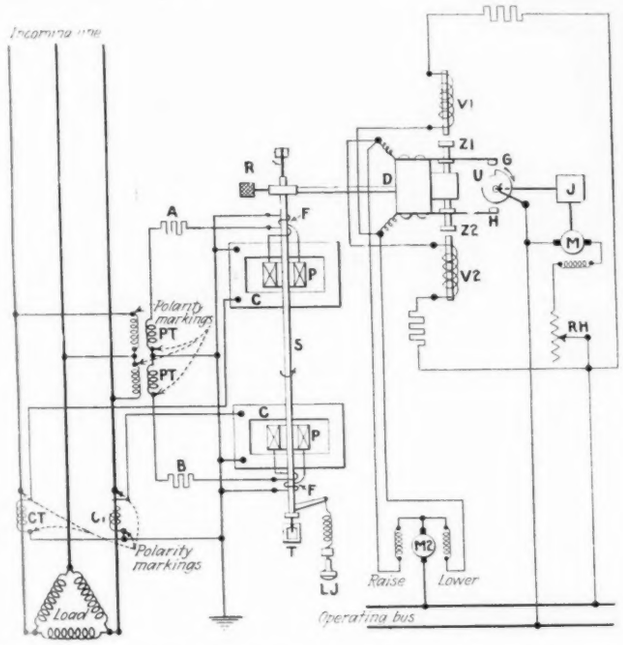


Fig. 5—Elementary connection diagram for wattmeter-type load regulator

110-volt secondaries. Great care should be exercised to connect them properly with respect to their polarity markings. Fig. 5 shows the proper relation of these markings for a three-phase circuit.

Making Adjustments

With reference to the top view of the regulator mechanism (Fig. 6) the adjustments are first, the potential element, which is wire suspended, should be adjusted when necessary so that it will hang clear of both the upper and lower guides. This is accomplished by means of screw A. Approximately $\frac{1}{32}$ in. space should be obtained at each end of the element so that it will be suspended by the center wire only.

With the contact arm B held in its center position, the two contacts C and D should be adjusted by means of armature screws E and F so that neither of the contact tips strikes the contact cam K when it is in motion. This clearance distance should be made as small as possible consistent with stability of operation, and is usually approximately 0.005 in. on each side.

The air gap between the heads of the armature screws E and F and the ends of holding magnet

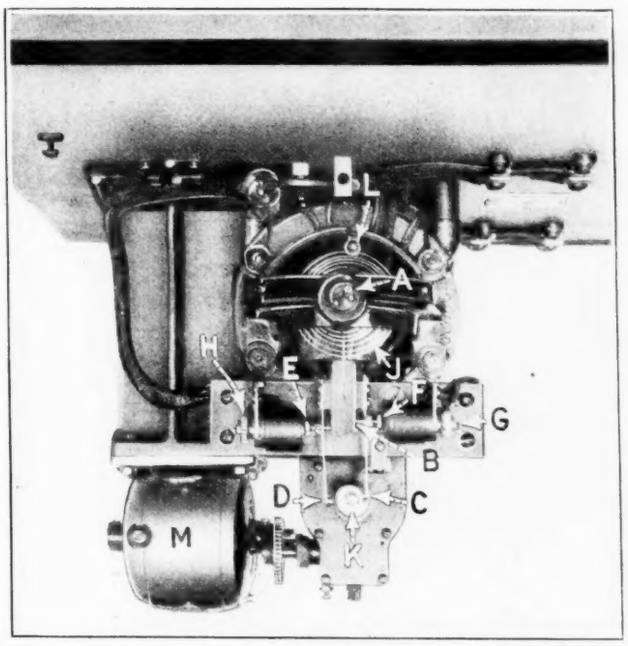


Fig. 6—Top view of wattmeter-type load-regulator control mechanism

core screws H and G should be so adjusted that firm contact will be made between either contact C or D and the rotating contact cam when either of these contacts strikes the cam with an increase or decrease of load.

With the load adjusting spring LJ, Fig. 5, in its lowest position and the load held at its minimum value, the spiral spring J should be so adjusted that the contacts C and D will come to a middle position and thus make no contact with the cam on either side. This adjustment can be readily made by loosening screw L slightly and moving the spring a small amount in the slot, after which the screw should be securely tightened. Final adjustment for the load required should be made by means of the load adjusting spring LJ, Fig. 5.

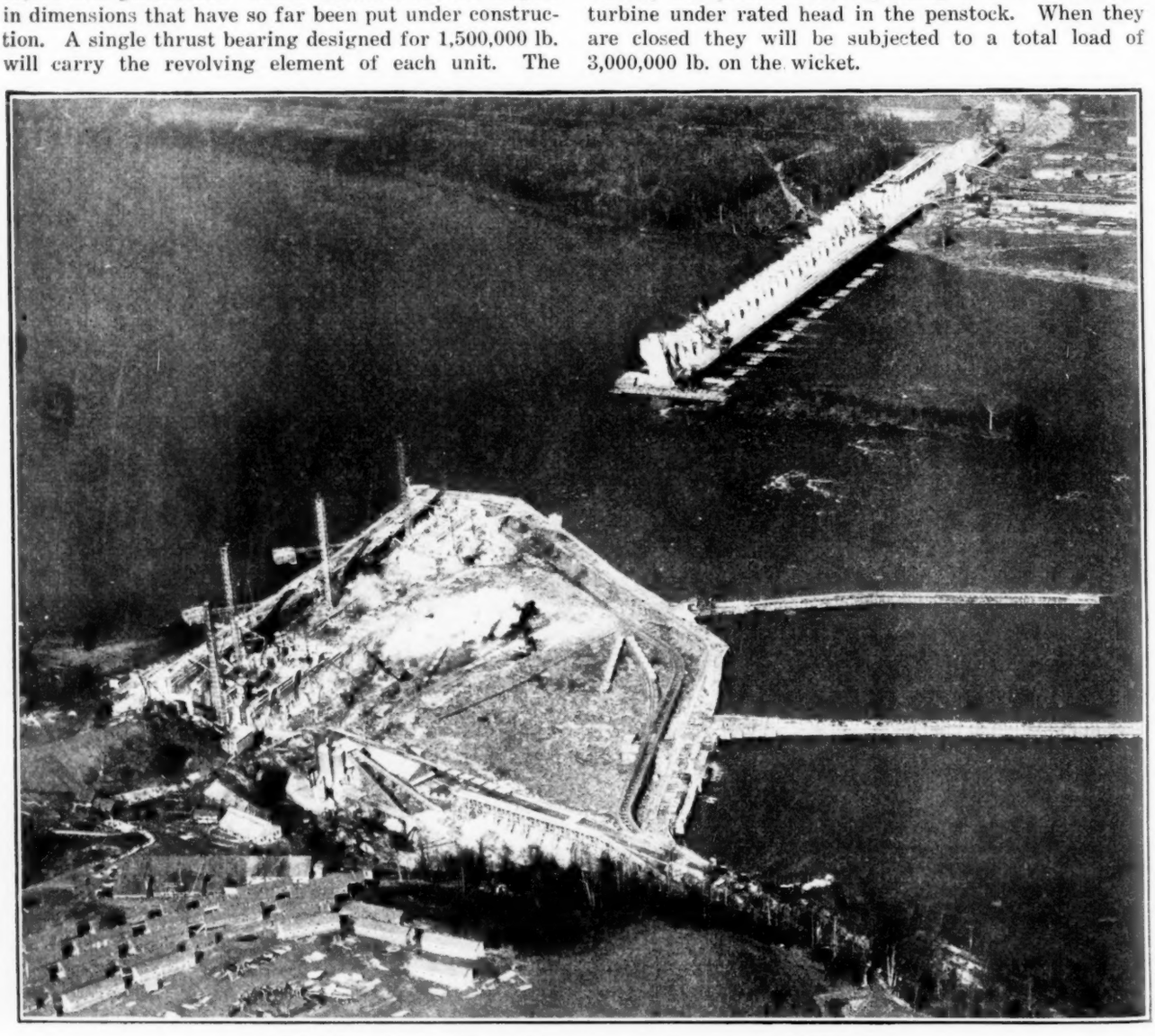
The efficiency of a riveted joint depends on the combination of dimensions as well as on the type of the joint, and there is no fixed relation between efficiencies of the different types of joints. However, for strength and sizes of material used in present-day boiler construction, the relative efficiencies obtainable with different types of joints are approximately as follows: Single-riveted lap joints, 57 per cent; double-riveted lap joints, 74 per cent; butt and double-strap joint, double-riveted, 82 per cent; butt and double-strap joint, triple-riveted, 87 per cent; and butt and double-strap joints, quadruple-riveted, 94 per cent.

Conowingo Hydro-Electric Development Progressing Rapidly

AT CONOWINGO, on the Susquehanna River in Maryland, one of the largest hydro-electric projects in the country is well under way. The project consists of a concrete dam about 4,800 ft. long and a power house which will have an ultimate capacity of about 600,000 hp. This development was started about the middle of last year and is now well under way, as is indicated by the airplane view shown on this page. In the lower center is shown the excavation for the power house and in the top right of the photo the dam can be seen, built out to the middle of the river. It is expected that the plant will go into service in 1928.

In the initial installation there will be seven 54,000-hp. vertical-shaft Francis-type wheels connected to 40,000-kva. generators. These machines are the largest in dimensions that have so far been put under construction. A single thrust bearing designed for 1,500,000 lb. will carry the revolving element of each unit. The wheels will operate under a head of 89 ft. and run at 81.8 r.p.m. These machines are not only the largest in size that have ever been built, but have the largest capacity for machines under 100-ft. head. The outside diameter of the generators is 37 ft., and the waterwheel runners have an outside diameter of 17 ft. 9 in. and weigh 200,000 lb. Plate-steel spiral casings are used, which have an inlet diameter of 27 ft.

A butterfly valve connects each waterwheel casing to its penstock. These valves will be 27 ft. diameter, which exceeds the diameter of the butterfly valves in the penstocks of the 70,000-hp. turbines at Niagara Falls, by 3½ ft., the latter being 23 ft. 6 in. diameter. The Conowingo valves are designed to close against the velocity and pressure corresponding to full load on the turbine under rated head in the penstock. When they are closed they will be subjected to a total load of 3,000,000 lb. on the wicket.



Recent airplane view of Conowingo water-power development

Location of Central Power Plants and Coal Selection

A Summary of Problems Drawn from Experience in Picking a Location for the Plant and in Securing Fuel and Water Necessary for Operation. Few Mine-Mouth Locations Justified

By S. A. TAYLOR*
Consulting Engineer, Pittsburgh, Pennsylvania

AMONG the public generally there seems to be a great deal of misinformation as to the requirements of the central power station. Advocating the building of the power plant at the mouth of the coal mine is one of the usual fallacies indicating a lack of knowledge of the water requirements and the suitability of whatever water supply there may be near the mine. Locations where there are abundance of coal and good water are few, and if to these two prime factors is added the problem of securing a site near the center of power distribution, the number of suitable locations for a power station is reduced still further.

In the location of a power plant the first consideration must be given to the distribution of the current to the consumers. If this distribution is for a large city and surrounding communities, it probably will be found desirable to build the plant where land and water can be secured, and if fuel is not close at hand, it is a question of obtaining the most desirable coal at the lowest freight rate.

Where the power plant is to serve large areas, it may be possible to erect the station where both fuel and water can be obtained. In many instances such a site has proved desirable notwithstanding the fact that the location entails considerable expense for power lines.

If the coal can be furnished directly from the mine to the plant, then study should be given to the delivery and storage and to the disposal of the ash. Other items to consider are the railroad facilities and the unloading of coal cars by gravity or at a low cost.

Selection of Coal

The use of coal in small sizes in stoker-fired plants or in the powdered form has been a fortunate circumstance for the producer and for the conservation of the coal supply. Since the mine-run basis of paying the miners for producing coal was introduced, the fine coal has increased considerably, owing to the fact that the miners shoot the coal much harder than when they were paid for screened coal only. More fine coal is now produced in the mining process, and in addition, the miners load out all the fine coal which, formerly, under the old basis of payment, was thrown into the gob and allowed to remain in the mines.

When properly prepared and cleaned of the excess ash, this fine coal will have about the same heat value as lump coal, and in some seams having coal of a friable nature, the fine coal is better than the lump, owing to the lower sulphur content. It goes without saying that the fine coal is better adapted for use on stokers and where powdered coal is used less preparation is required.

Another factor requiring consideration is the quantity of coal to be secured to care for future requirements. In such cases sufficient quantities of coal have been secured to supply the plant to a time extending beyond the maturity of the bonds.

To avoid a heavy overload for the capital account, this capital loading calls for careful calculation, for to the purchase price of the coal lands must be added the taxes and carrying charges. The taxes are difficult to forecast, but carrying charges can be determined quite accurately, and unless intimate study has been given to this problem, the exact figures are likely to be surprising. The accompanying table gives the value of a dollar compounded annually for each five-year period, as well as the present worth of the dollar as of these periods.

VALUES OF $1 ON 6 AND 7 PER CENT BASIS

	6 Per Cent Basis		7 Per Cent Basis	
Period, Yr.	Value	Present Worth	Value	Present Worth
5	$1.33	$0.7473	$1.40	0.713
10	1.79	0.5584	1.97	0.508
15	2.40	0.4173	2.76	0.362
20	3.21	0.3118	3.87	0.258
25	4.29	0.2330	5.43	0.184
30	5.74	0.1741	7.61	0.131
35	7.69	0.1301	10.68	0.094
40	10.29	0.0972	14.97	0.067
45	13.76	0.0726	21.00	0.048
50	18.42	0.0543	29.46	0.034

The 7 per cent basis is more nearly what a coal property should be charged. From these figures it will be easy to determine the cost of coal for the plant over a period of years, and it will enable the engineer to determine whether it will be more economical to purchase the coal field outright or to make a lease for the coal.

Where the power plant is near an ample supply of water and near the center of distribution of power, but where the coal must be shipped into the plant, quite a different problem is encountered. Here the location of the mine that will give the best grade of coal, taken together with the cost of production and the cost of transportation at the present time, as well as a forecast of the future as to what will happen to change the cost of the fuel, must be considered. More attention must be given to the quality of the coal than in the first case, for the freight charges on poor coal generally are the same as for coal of good quality. The cost of high-ash coal and the disposal of the greater amount of ashes from the plant must be balanced against the higher cost of low-ash coal and the lesser cost of disposing of the ashes. In all cases the efficiency of the plant must, of course, be taken into account.

*Abstract of paper presented before the Midwest Power Conference, Chicago, Feb. 18, 1927.

The Key to Economical Compressor Operation

HOW the actual operation of air compressors differs from the theoretical ideal, as shown by a comparative study of indicator diagrams. Suggestions for keeping up efficiency and capacity.

BY WILLIAM V. FITZGERALD

THIS article deals with five effects of thermal changes in air during compression. These may be listed as follows:

1. Atmospheric air is heated during suction, so that the initial temperature is never the same as atmospheric temperature.

2. Still further heating occurs during the early part of the compression stroke in addition to the heat of compression, and therefore the actual curve may lie partly above the adiabatic curve.

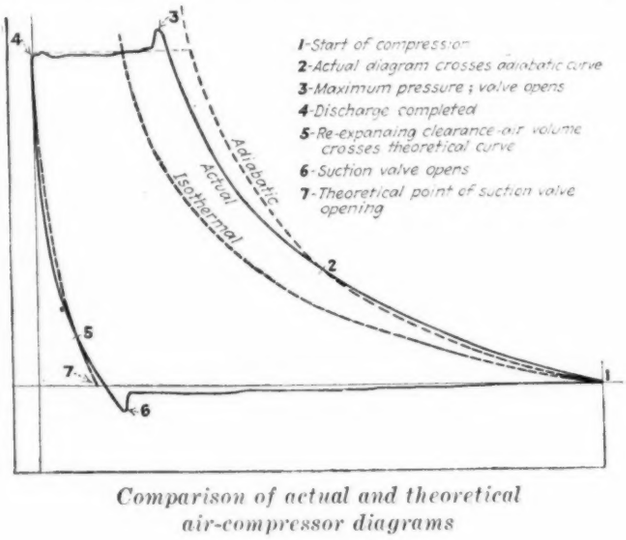
3. Because of the higher initial temperature, horsepower consumption is increased per pound of air compressed or delivered.

4. Thermal changes tend to make the re-expanding clearance air fill a greater space than indicated on the theoretical diagram, thus reducing the capacity of the compressor.

5. An indicator diagram may falsely show high efficiency or normal operation due to mechanical or thermal conditions.

THEORETICAL DIAGRAMS

Theoretical diagrams and actual air-compressor diagrams differ in a manner that is often not clearly



Comparison of actual and theoretical air-compressor diagrams

understood. The following explanations deal with tendencies in actual air-compressor diagrams, which may be unnoticed, but are nevertheless present and influence the operation of the compressor.

A theoretical diagram based upon adiabatic compression with 5 per cent clearance is shown in the illustration. This diagram (in dotted lines) gives graphically the pressure-volume behavior of air during compression, discharge and expansion of the clearance air.

In the first place, air at 60 deg. and atmospheric pressure is assumed to pass into the cylinder, to fill the cylinder during the suction stroke and to remain at 60 deg. until the compression stroke has started. Next, the compression by the piston is assumed to raise the temperature and the pressure in accordance with the law "PV^n equals a constant."

The pressure is assumed to reach a certain maximum at which discharge takes place. Subsequently the compressed air in the clearance space re-expands until the pressure reaches the atmospheric line. It is assumed that no heat is given up or added to the air during compression or expansion.

It is generally thought that, owing to the cooling effect of the cylinder walls, the actual curve of compression lies below the theoretical adiabatic curve during the entire compression stroke.

In actual compression the air temperature is increased to about 300 deg. F. under normal operating conditions. The heat generated by the compression is partly dissipated through the agency of the cooling water and through the cylinder head. The head is probably the hottest part of the cylinder, for the reason that it comes in contact with the hottest air and because it is less easily water cooled than other parts of the cylinder. The valves, located in the head, are therefore very hot, the discharge valves being more so than the suction valves.

Now, the air taken into the cylinder from the atmosphere must necessarily pass through the heated suction valves in the cylinder head. Passing in a thin stream over or through the heated valves, the air becomes heated.

Furthermore, the air enters the cylinder at a temperature considerably below that of the cylinder wall and cylinder head. In its agitated state it comes into contact with these surfaces and thereby acquires additional heat.

When the suction stroke has been completed and the compression stroke begun, the air has absorbed sufficient heat to raise its temperature from the 60 deg. (say) of the atmosphere to perhaps 80 deg. or 90 deg. F.

Theoretically, the air in the cylinder is at a temperature of 60 deg. Actually, its temperature may be 80 deg. or higher. This affects the operation of the compressor in two ways. First, owing to increased temperature, the volume of air is increased and therefore the weight of air per cylinder volume is less. Second, the temperature of the air is higher as the compression starts; this results in a final higher temperature.

During the early part of the stroke no heat can be given up to the cooling water, because the cylinder walls are then hotter than the air in contact with them. Consequently, heat transfer occurs the other way, the air being heated by the cylinder walls.

This part of the cycle is indicated in the diagram by the full line, which is shown to lie above the adiabatic curve during the early part of the stroke.

When the temperature of compression equals or exceeds that of the cylinder walls, the cooling water begins to become effective and the actual compression curve soon passes beneath the adiabatic line and lies thereafter below it, owing to the removal of heat by the cooling water.

In the actual curve there is the effect of the pressure increase necessary to open the discharge valve, which pressure is indicated on the diagram.

When the discharge of air has been completed, and the piston starts back re-expansion of the clearance air takes place before intake can begin. Here again, there is a variation from the theoretical curve. During the early part of the re-expansion, the air is much hotter than the cylinder walls and head and some of the heat is transferred to the metal. When, however, the expansion continues, the temperature rapidly decreases until, finally, the process is reversed, heat being transferred from the cylinder walls and head to the air.

Thus the re-expansion line drops "below" or back of the theoretical line during the first part of the stroke, but crosses it at some point near the atmospheric line. The pressure continues to drop beyond the atmospheric line due to the partial vacuum required to open the suction valves. Pressure in the cylinder is slightly below the atmospheric during the remainder of the stroke.

How Heating of Suction Air Affects Capacity and Efficiency

The increase in temperature of the suction air decreases the weight that can be drawn into the cylinder at a given atmospheric temperature. If, for example, air at 60 deg. were being compressed in a cylinder of one cubic foot capacity, and the air were heated to 90 deg. during the suction stroke, the weight of air in the cylinder would be decreased from 0.0764 lb. to 0.0723 lb.—a difference of 0.0041 lb. per cubic foot.

It would require about 0.14 hp. theoretically to compress each cubic foot of air (per minute) to 65 lb. gage, regardless of temperature. To compress one pound of air per minute, however, would require 13.1 $\times$ 0.14 = 1.83 hp. for air at 60 deg., while it would require 13.84 $\times$ 0.14 =1.93 hp. at 90 deg. This change is in no way attributable to the change in temperature, except as temperature influences volume. The additional power required to compress a pound of air per minute at 90 deg., as compared with air at 60 deg., is 0.10 hp. The difference for 1,000 cu.ft. per minute at 60 deg. and the same weight at 90 deg. amounts to 7.6 hp.

For economy the compressor and suction valves (particularly the latter) should be kept as cool as possible so that the suction air will remain at or near the same temperature as the atmospheric air.

A compressor working at an initial temperature of 90 deg. will have a final temperature much higher than if the initial temperature is maintained at or near 60 deg. The effect of increasing the temperature of the intake air is to increase the temperature of the discharge air and consequently, of the cylinder heads and valves.

Causes of Variations in Diagrams

The relation between the actual diagrams and the theoretical diagrams may show wide variation due to mechanical faults in the compressor. There are certain abnormal conditions of operation that make the actual curve tend toward either the adiabatic or the isothermal.

The conditions tending toward adiabatic are:

1. Insufficient cooling.
2. Heating due to friction.
3. Leaky discharge valves.
4. Formation of carbon, reducing clearance space.
5. Heating of intake air during suction and early compression.

The abnormal conditions tending toward the isothermal are:

1. Leakage of air past piston rings.
2. Leaky suction valves.

Naturally, the actual curve lies nearer the adiabatic than the isothermal. Hence an actual curve approaching the theoretical isothermal curve does not always indicate a high efficiency, but rather should be regarded with suspicion as being due instead to some abnormal condition.

On the other hand, a curve approaching the adiabatic may be caused by any of the first-mentioned conditions. A thermometer placed in the cooling water flowing into the compressor, and another thermometer placed in the discharge-water line, will help check up on the actual conditions within the cylinders. A thermometer in the discharge air line will also be of service in detecting any mechanical or other condition that would require adjustment.

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2. The identity of the plant must be revealed in the text and the story must be subject to verification.

3. Articles should be as short as consistent with telling the facts; preferably not exceeding 4,000 words exclusive of illustrations, which are desirable.

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5. Articles which do not win prizes, but which possess sufficient merit to warrant publication, will be used subsequently and paid for at regular rates.

6. The competition is open to all without regard to position.

7. Names of the judges selected by the editors will be announced later.

Care and Inspection of Electric Steam-Flow Meters

PROPER care of meters is necessary if the best results are to be obtained. In this article a plant engineer tells how he takes care of his steam-flow meters and checks their operation.

BY J. ELMER HOUSLEY

AT NOT less than yearly intervals steam-flow meters should be completely dismantled, inspected and repaired if necessary. It is particularly important where they serve a steam-heating system and furnish a basis for cost billing. The evil consequences of flow meters' standing idle are greater than if they are in continuous service because scale and corrosion make their attack best in quiescent surroundings. The following discussion covers only one of several classes of steam-flow meters, the Republic electric-resistance type.

The installation herein discussed consists of a thin plate of Monel metal with a circular opening smaller than the pipe, in which the plate is inserted between a flanged joint, as indicated in the diagram, Fig. 1. The contraction of the moving steam produces a drop in pressure, which is greatest at some point beyond the orifice. This difference in pressure, called the differential pressure, bears a certain relation to steam velocity. To transmit the differential pressure, a $\frac{3}{8}$-in. pipe is tapped into the steam line on either side of the orifice. After passing through a valve, each pipe enters a small reservoir *O*, Fig. 2, which acts as a condenser and maintains an equal column of water in each pipe leading to the meter body.

Meters Measure Electrical Energy

In the schematic diagram, Fig. 1, it will be noted that *A* represents the high-pressure or leading pipe and *B* the low-pressure or trailing pipe. The mercury in the meter body shown in the diagram rises, touching the contact rods one after another as the differential pressure rises. This cuts out, one after another, the resistance coils, and the resulting current in the circuit is measured, in this instance by an integrating watt-hour meter, a recording ammeter and an indicating ammeter.

The meters measure electrical energy directly, but are calibrated in terms of pounds of steam per hour at a definite pressure and quality. The current in the installation in question was supplied from one phase of a 440-volt 60-cycle motor circuit in the boiler room, through a 440- to 40-volt 100-watt transformer. Several taps were provided to furnish 40-volt secondary current in case the system voltage might be higher or lower than 440. The potential circuit of the watt-hour meter was energized at 40 volts. Later types of this meter are provided with compensation to correct for voltage fluctuations. The circuit requires one ampere flowing in the meter to give full-scale reading.

The construction of the meter body is shown in the phantom view, Fig. 3. Two valves *A* and *B* close the connection between the meter body and the steam main. A union joint at the lower end of the valves serves to disconnect the meter body from the piping. The pipe *A*, on the left when looking at the front of the meter, connects to the leading side. The right-hand connection *B* goes to the trailing side. The two pipes are joined through a seal *C*, which is a U-shaped connection partly filled with mercury. The seal protects against the loss of the main body of mercury at *D*. When a surge occurs with a higher differential pressure than the mercury column can resist, the mercury in the seal *C* is forced into the water compartment at *E* and allows the water to blow through as long as the excessive pressure exists. As soon as the differential pressure becomes normal, the mercury returns to the seal.

A valve *F* between the two water compartments is opened should it be necessary to equalize the pressure

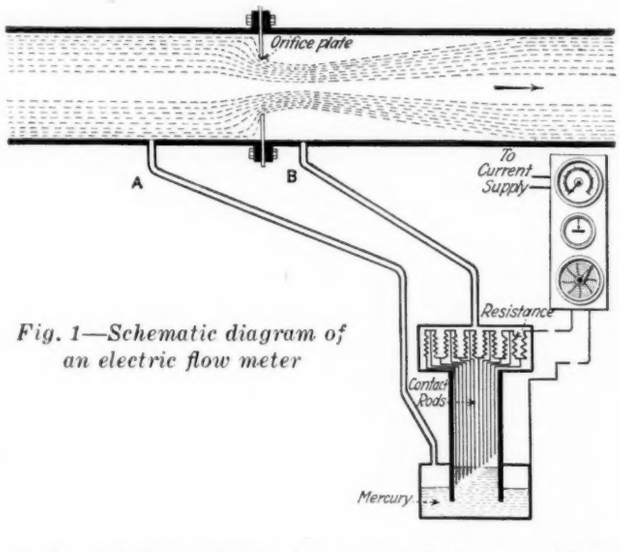


Fig. 1—Schematic diagram of an electric flow meter

on the mercury columns for a zero check or to fill the connecting pipes with condensed steam by circulation. As will be noted in the phantom view, the leading pipe *A* connects to the mercury well *D* and the trailing pipe to the annular space around the contact chamber *J*. As the differential pressure increases with the steam flow, the higher pressure in the well forces the mercury up into the contact chamber. The space above the mercury is filled with transformer oil to prevent the mercury and contact rods coming in touch with the dissolved gases in the water, which would invite oxidation.

To give the meter a thorough internal inspection, disconnect the unions which are a part of the valves marked *A* and *B* after closing these valves. The entire assembly, including the body, seal piping and attached parts, may be removed to a convenient workbench, being careful to

not tip the meter over while carrying it. Remove plug *G* and catch the oil in a clean container. Tip the body straight toward you while standing in front of the meter, until the mercury appears. Next, secure an earthen pitcher and tip the meter body still farther, until the mercury is drained from the main body of the meter. Then remove the plug *H* and tip the meter body

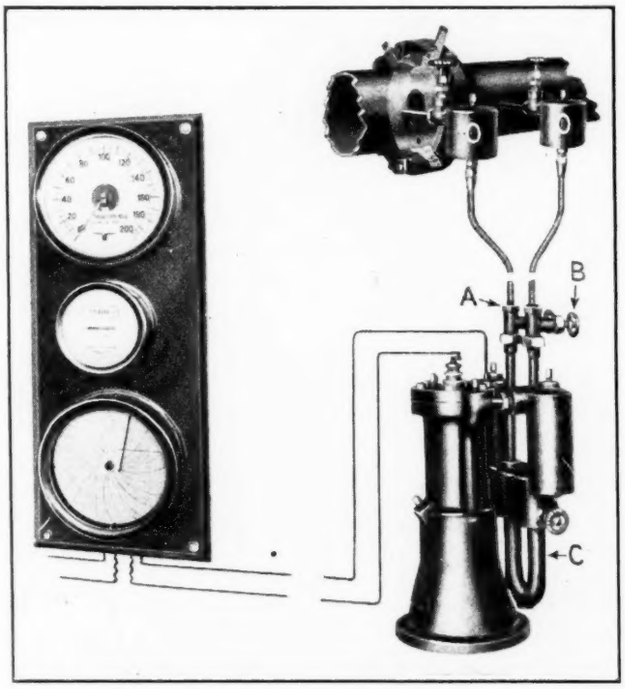


Fig. 2—General arrangement of the parts comprising a metering unit

over sideways to drain the mercury from the seal, using another earthen container in order to keep the two portions of mercury separate. Any water or oil that may come out with the mercury may be poured off the top. The mercury should be poured through cheesecloth several times in order to remove any scale or sediment; and should not come in contact with any ordinary metal containers, as it will form an amalgam that cannot be separated except by a distillation process.

Cleaning the Meter Body

The meter body should be washed inside and out with a high-pressure stream of water, and afterward with gasoline, first having removed the flanged head and the resistance element at *K*. This should remove any sediment or scale that may have formed or become loosened on the inside of the meter body. If compressed air is convenient, it may be blown inside the meter body with a nozzle. The mercury may be poured back into the main body, and the seal mercury should be returned through the seal pipe ends at *A* or *B*. The cover should be fitted with a new gasket and the cover and resistance element put back, first wiping the contact rods with a clean cloth. The cover may be bolted down and the meter body returned to its position. About a pint of water may be poured in the two seal pipes, with the bypass valve open, then the transformer oil poured in the plug openings *M*, one on each side of the case. There are five plug openings on the top of the meter body, all of which should be open when the oil is poured into the case.

The oil as it is returned should be strained through a fine cloth, and a small quantity of new transformer oil will be needed to make up for that lost in handling. The drain plug *G* may be loosened slightly to allow air to escape from the mercury well; then the openings at *M* should be filled completely and all plugs replaced. The seal pipes should be filled with water and the meter body is ready to connect back into the line, but before doing this the connecting pipes should be blown down by opening valves *A* and *B*.

If the meter connects to a line that is dead a portion of the time, the valves should be left closed and the meter pipes connected up temporarily to keep dust out of the system. When the steam is again turned on, the pipes should be disconnected and the lines blown down, as previously explained. After the meter is put in service, the bypass valve at *F* should be opened, leaving valve *A* open and *B* opened very slightly. This allows

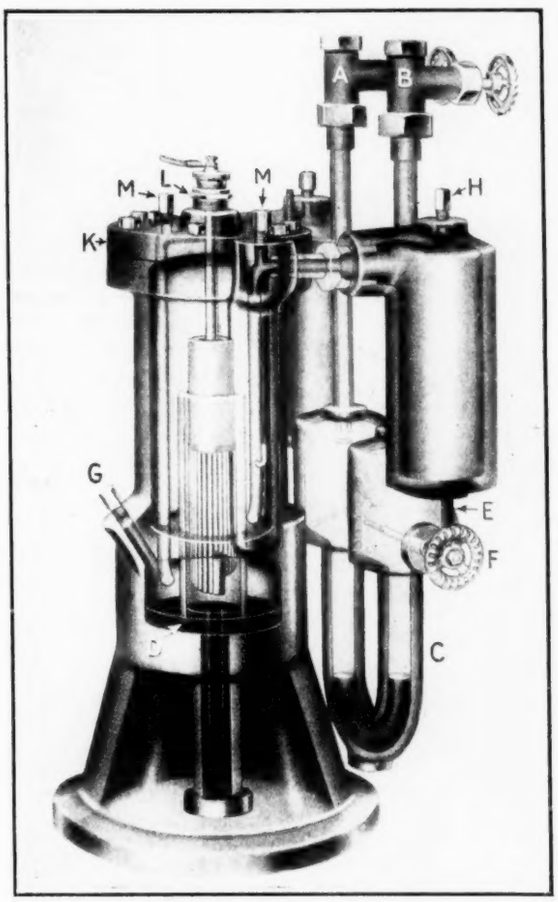


Fig. 3—Phantom view of meter body

the steam to condense in the pipes and the water to move through them slowly and carry out any air that may have become pocketed in the line.

To set the meter at zero, valves *A* and *B* should be closed and valve *F* opened to balance the mercury columns. An adjusting nut *L*, just below the terminal on the insulated rod coming out the top of the meter, may be turned so as to lower or raise the contact element. The element is lowered until the watt-hour meter

disk revolves; next, the element is raised until the disk stops, which indicates the zero point for the meter. To check full scale reading approximately, a low-reading alternating-current ammeter may be connected in the circuit with a variable resistance, and the terminal at the meter body short-circuited. When the current in the circuit is adjusted to one ampere, the meters should give full-scale reading. All terminals should be inspected carefully and cleaned and tightened if found loose.

Checking the Meter Readings

The job is not complete, however, unless the meter is sensitive and shows the variations in flow due to various units of the (heating) system being cut in or out. If the meter is sluggish, it is of course inaccurate. This condition is easily detected on a recording chart when the line appears too smooth. Such a chart is shown in Fig. 4. In this case two troubles existed. The zero adjustment had not been made accurately and the meter was reading high and it was not sensitive to variations in demand. The pipes were disconnected from the meter body and were blown down, and quite a little scale came out, although they were apparently blown clean the day previous. After being reconnected and the pipes filled with water and air removed, the meter responded to all changes in steam flow.

We were able to make an independent check on steam flow, as there was one boiler supplying this line. By shutting off the boiler feed and taking the time required to drop the water 15 in. in the boiler gage glass, which was 10,000 lb., the steam flow was readily calculated. A

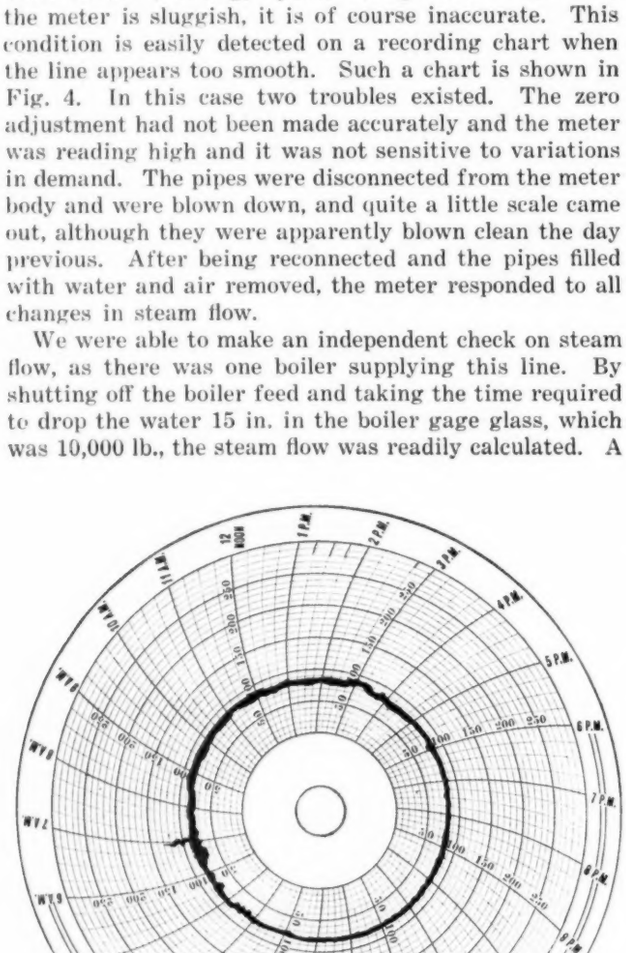


Fig. 4—Chart obtained when meter was sluggish

typical chart taken later is shown in Fig. 5. The chart was put on at 7 a.m., at which time the steam demand was high, due to bringing up the temperature of the offices and shops from 65 to 75 deg. At 7.30 a.m., the demand dropped off. It declined still further at 11 a.m. and at 2 p.m. after the offices were closed on Saturday afternoon. After 6 p.m. the outside temperature declined and the heating was increased in the plant washrooms for the night shift. Between 6 a.m. and 7 a.m. on Nov. 7 the demand did not increase as on the day before, because the office and shop temperature were not brought up, the day being Sunday.

The charts show that the steam flow ranges too low for the chart scale, but the steam line was designed to

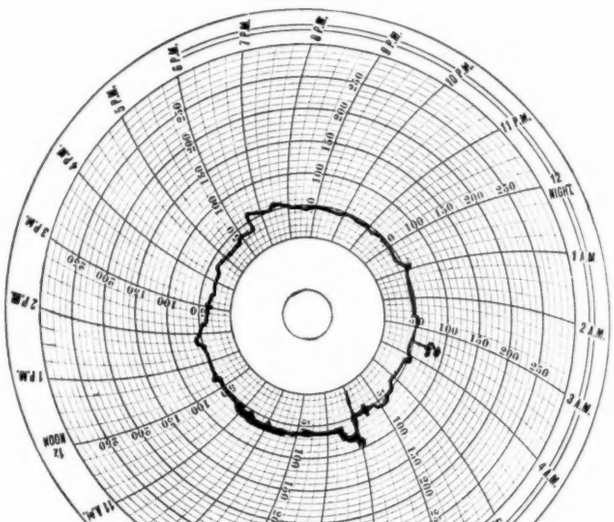


Fig. 5—Chart obtained when meter was working properly

supply process steam at various times, when it cannot be fully supplied by waste-heat boilers. The integrating meter is read at 7 a.m. and the reading set down on the recording chart, and the total steam is figured in the office.

Proper Height for the Oil in Elevator Gear Cases

There is an idea among many maintenance men that the higher the oil is kept in elevator gear cases, without its running over, the better the worm and gear are lubricated. This, however, is absolutely wrong. When the worm is completely immersed in the oil, it acts as a pump and not only increases the power consumption for operating the machine, but also tends to heat the oil, and in addition it works out of the gear case and creates a dirty condition around the machine. For best lubrication of the worm gear, the oil level should not come above the center line of the worm shaft, and some manufacturers arrange their machines so that only the lower side of the worm dips into the oil. To prevent too much oil being put into the gear case, an overflow of large dimensions is provided. This overflow also furnishes a means of determining the amount of oil in the gear case.

When the worm is located over the gear, as it is on some modern machines, it is removed from the oil reservoir entirely and the oil is carried from the reservoir to the worm by the gear. In this case it is well also not to keep the oil too high, but to maintain the level so that the lower side of the gear will dip into the oil about two inches.

Making Tests on Waterwheels

MORE attention is now being given to the testing of waterwheels in place than at any previous time. This is being done not only to determine if the manufacturers have met their guarantees, but also to establish a basis for operating the units. The latter is of equal importance with the former, as knowing that the manufacturers meet their guarantees is of little use if the efficiency of the wheels is forgotten after the tests, as long as they carry their load.

The testing of a waterwheel in place is by no means a simple operation for those not familiar with such work. Many conditions that require the attention of experts, develop when making these tests, particularly while the initial tests are being made and a technique of doing this work in a given plant is being established. There is nothing about the tests that cannot be successfully accomplished by the engineering staff in the average plant, after the details of making them have been provided for. In no two plants are the conditions the same, and what may give the most accurate results in one will not in another.

In addition to making the tests, there is the problem of working out a plan of operating the units to obtain the most efficient combinations. Here again the assistance of an engineer with wide experience in making tests will prove valuable. It is generally recognized that the services of an experienced consulting engineer may prove of great economic value in working out an operating schedule and making recommendations for a steam plant. Although not recognized to the extent that it should be, water costs money and should receive economic consideration as well as coal which is purchased at so much a ton.

The Outdoor Power Plant

NOW and then somebody advocates eliminating the major portion of the building structure of a power plant. Hydraulic plants have been built with a low turbine-room roof, with removable hatches, and with an outdoor gantry crane for handling machinery and carrying it to a repair shop at the end of the plant. There is talk now and then of leaving off the roof altogether. Not long ago a leading steam-plant designer said that perhaps the same development might come in the steam field.

Boilers do not need to be housed, he said. Of course there would be a control room, instrument shop and the like, but these could be grouped in a small house. Each boiler setting is in itself a house. Coke ovens are not roofed over. Why boilers?

It is not so easy to think of turbine-generators unprotected against the weather, but why not? The electrical apparatus could be made weatherproof. Transformers, switches and the like are commonly placed out of doors. Why not the generator? The turbine, too, might be arranged to make exposure possible, or perhaps the governor, oil piping and other small trappings about the head end might be protected by a removable hood. Pumps and motors serving the condenser need not be housed. Units of similar size commonly operate in the weather.

It would doubtless be easier to protect against rain and snow than against cold. The extensive steam and water piping of a power plant would of course be sensitive to freezing temperatures.

And then there is the difficulty of overhauling machines out of doors. One would not care to open a turbine or remove the field from a generator without the protection of a tight roof, and it would be immaterial whether there were no roof or a hatched roof, since crane service would require the hatch to be removed for such work. Large units are too heavy to be removed bodily to a repair shop. They must be dismantled in place.

On the other hand, considerable money might be saved by the reduction of the building costs to a minimum. There would be some offsetting additional expense in making the individual units weatherproof.

Why discuss further? The idea has been seriously advanced by a man of high reputation. It is not altogether good. Is it altogether bad?

Old-Time Thoroughness Plus Modern Ideas

"THOROUGHNESS" was the watchword of the real engineer in the good old days. Today it is "progress." But to be open-minded, alert, abreast of the times (in short, not to be a fossil) does not mean that one must bid good-by to the old-time virtues.

That ancient and modern virtues can go hand-in-hand was forcibly brought to the attention of one of *Power's* editors on a recent New England trip. He visited by invitation the power plant of an old manufacturing concern in a small town near Boston.

There was a plant for sore eyes! Built two years ago to replace an obsolete installation, it didn't look a day old. Fine equipment, neatly arranged and amply housed—a wide-awake engineer, in love with his job—loyal subordinates—and everything groomed like a race horse! Here was all that modern engineering could provide, *plus* the finest kind of old-fashioned power-plant housekeeping—the "engine-room variety" at that. You could eat your lunch off the boiler-room floor and hardly get your hands dirty.

"But how about it?" one can almost hear some hard-boiled engineer ask: "Are power plants run to earn dividends or to please the ladies' auxiliary?"

Right here is where the fun begins. The efficiency obtained in this plant is remarkable. Most other plants equally well fixed in the way of boilers, stokers, com-

bustion-control apparatus, meters, etc., could not touch it. The actual figures will be withheld for an article that is to be published soon, with sufficient data to support claims that might otherwise be mistaken for pipe dreams.

The operating data show beyond a doubt that the grooming does not stop at the outside. The boilers are as clean inside as out. Moreover, the settings and baffles are tight; otherwise the flue temperature and over-all efficiency could not possibly be what the records clearly show. Every piece of apparatus is in tune. As a result, the power-plant orchestra is playing a symphony as sweet to the ears of the owners as it is to the engineer. More power to such plants!

Making a Workable Standard Is a Worthy Task

VOLTAGE standardization has been an active subject in the electrical industry for nearly thirty years, and although standards have been established at different times, we find ourselves at present without a workable system of standard voltages. The discussion on this subject at the recent Winter Convention of the American Institute of Electrical Engineers indicates that there is a wide difference of opinion as to such standards. This probably is not as serious as it might appear at a casual consideration, for although there are variations in the different voltages used, these are not so large but what most of them could be taken care of in the supply and receiving apparatus. Furthermore, there probably never was a more opportune time for establishing voltage standards than the present. The introduction of the tungsten lamp has made possible the establishing of standard utilization voltages, and the plans for expanding power systems have apparently been pretty well formulated.

Having standard utilization voltages and a plan of supplying them, it should be possible to establish a standard system. To do this it will be necessary to provide a certain flexibility in the supply equipment to take care of minor changes in voltages due to different conditions prevailing on the system. One of the difficulties in applying voltage standards in the past has been the use of transformers with a fixed ratio. The farther the transformer is from the source of supply, the greater the line drop will be generally, and unless taps are provided in the transformer to change its ratio, a standard utilization voltage cannot be maintained. It is now generally agreed that the utilization voltage should be used as a basis of standard system of voltage.

Any system of standard voltages that may be established will no doubt have to be a compromise and at the beginning will not be acceptable to everyone. However, a workable standard based on sound principles is worthy of the best effort that the industry can give to making it a reality and, when set up, will have great economic value in future developments.

Another Method of Supercharging

THE volume and weight of the Diesel engine per unit rating have led many to experiment with supercharging. The increase in the weight of air introduced into the cylinder by permitting the burning of more fuel increases the output of the engine. This is obtained through a greater mean effective pressure, and this entails a high terminal or release pressure. That the high-temperature gases destroy the exhaust valves has caused supercharging mainly to be used in two-stroke-cycle engines, and the kinetic energy of the gases has been used to operate the supercharging blower. The power increase is such that the reduced fixed charges overshadow any slight drop in thermal efficiency that might occur.

Recently, a new supercharging plan was advocated before the Metropolitan Section of the American Society of Mechanical Engineers by Elmer A. Sperry. Making use of the compound engine upon which he has been experimenting for years, he stated in effect that the old low-pressure cylinder becomes a balancing cylinder. The idea is that the exhaust gases cut the valve seats by reason of their high velocity, and by having the pressures on both sides of the valve almost equal, no valve cutting can occur. Incidentally, the action of the gases upon this balancing piston would result in work being done on the crankshaft.

Supercharging air from below the balancing piston would flow into the high-pressure cylinder through the exhaust, or, better named, the transfer valve.

Just how efficient the mechanism will be it is difficult to estimate. In the first place the pressures cannot be equal or no gas flow would occur. Again, even if the proper balancing pressure were established for a given cylinder condition, a change in load would immediately destroy the balancing. Under light loads the flow would be into the combustion cylinder, and at overloads the condition of high velocity would exist.

Compounding of internal-combustion engines is hardly feasible from a practical viewpoint, and the amount of supercharging is in all cases limited by the ability of an iron vessel to withstand the high heat stresses. The advantage usually advanced is that compounding will result in lighter-weight engines. This, if desired, can be brought about by higher speeds, for the revolutions per minute above which the fuel consumption becomes unsatisfactory are certainly three or four times the values employed on standard designs.

STAINLESS STEEL HAS BEEN USED IN EUROPE for economizer tubes. In this country a few stainless steel condenser tubes have been used. It would be interesting to know how these trials work out. Stainless steel must be properly heat treated in order to be stainless, and even then it is not resistant to sulphuric acid and to certain organic acids. Sulphur-bearing flue gas, in the presence of moisture, is responsible for external economizer corrosion, and it is at least questionable whether stainless steel would withstand such an attack. On the other hand, it is claimed that chromium plating is especially resistant to sulphur compounds. And the cost is not so high. Why not try it on the gas side of economizer tubes and air heater elements?

COMPETITION FOR THE POWER PRIZES, covering the best papers on power plant improvements, will react to the benefit of the contestants whether or not they are among the winning three; for a number of the contributions that possess merit will also be published. Aside from monetary considerations, the authors will acquire increased prestige with their employers, or prospective employers, their fellow engineers, or their clients, as the case may be. Conditions covering the contest will be found on page 287 of this issue.

Ideas From Practical Men

Readers are urged to use this department for the exchange of practical operating information. A minimum of five dollars will be paid for contributions accepted.

Installation of Air Tanks To Prevent Grooving

In most cases air tanks are placed in a vertical position with the concave head down. This is natural as it is the way of least resistance, but in my opinion it is not correct.

When a drain is placed in a tank in this position, it is not down to the bottom and the water cannot be drained

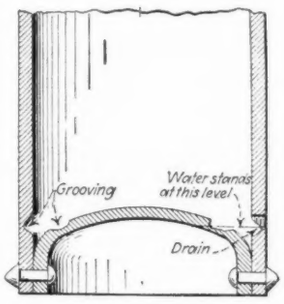


Fig. 1—Grooving in plates caused by water standing in tank below the drain

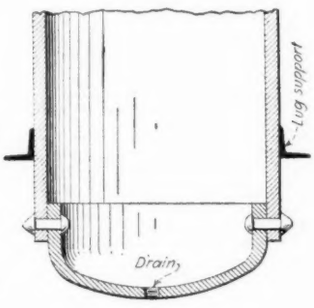


Fig. 2—With convex head downward drain is in lowest point of tank

out completely. Furthermore, when water is allowed to stand in the tank, grooving begins at the water level, and soon the tank is in a dangerous condition and must be discarded.

A more practical method of installing air tanks, it seems to me, is to place the convex, or bumped, head downward on a substantial foundation, and then the drain hole can be at the lowest point in the head or center of it, and in such a case the tank can be thoroughly drained. Such practice would prolong the life of a tank considerably.

The illustration shows how grooving took place in one tank which had to be discarded when only seven years old—a short life for an air tank. D. E. BISHOP.

Detroit, Mich

Stopping Gasket Leaks

In a small Diesel plant where I worked, there were two solid-injection engines, one a 50-hp. and the other an 80. We had considerable trouble with the 50-hp. engine leaking water badly around the head and combustion-chamber gaskets when anything like full load was applied. The same trouble occurred with the other engine, but only when it was idling or overloaded. New gaskets would remedy the trouble for only a short time.

A fellow engineer suggested that we change our circulating-water piping connecting the head of the engines to the cooling tower. These engines were piped to a small tank placed on a cooling tower in such a manner that there were fifty gallons of water in reserve after the engines were stopped, to maintain a full water jacket and thus prevent starting up with an empty jacket. There was, as a result, a few pounds pressure on the cylinder gaskets at all times. We disconnected these lines from the tank and rearranged them so that there was no pressure at all on the gaskets. We provided for full jackets when starting by connecting a line from the city water tank. After this was done, the 50-hp. engine would pull 40 per cent more load without leaking, and the 80 did not leak at any time. I am writing this because I realize that there are numerous plants where similar engines were having the same or worse trouble, and I hope this will prove of benefit to them. It most certainly did in this particular plant.

Kirbyville, Tex. CHARLES A. EHRET, ENG.,
Texas General Utilities Co.

Another Practical Use for the Indicator

For a number of years I have been getting a good deal of helpful service from the gas-engine indicator, other than taking the conventional cards. As shown by

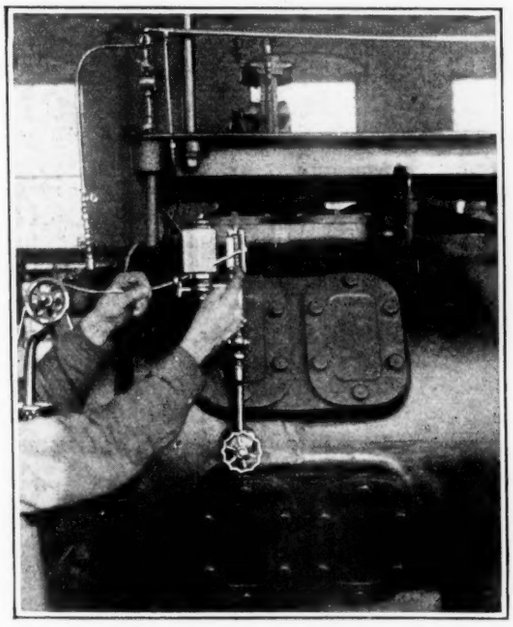


Fig. 1—Indicator in position on cylinder

the photograph, the indicator is put on a cylinder and the card drum is rotated by pulling the string by hand in short continued strokes of about ¼ in. after each explosion in the cylinder, thus getting a number of straight vertical lines. The height of these lines shows whether the cylinder is firing regularly and evenly.

With the constant-compression type of engine where

the mixture is regulated at the inlet valve of each cylinder, it is frequently found that the cylinders are not all doing the same amount of work. By taking a group of lines from each cylinder on the same card, by moving the indicator from one cock to another without removing the card, a comparison can be made as to how each cylinder is firing, and if there is any variation, the weak cylinder can be brought up to the others.

Chart *A* is an old one that was filed away a number of years ago. It shows that the No. 3 cylinder was hitting heavier than the rest, probably causing that cylinder to pound. Chart *B*, also an old one, shows that all the cylinders were running about the same, but the explosions

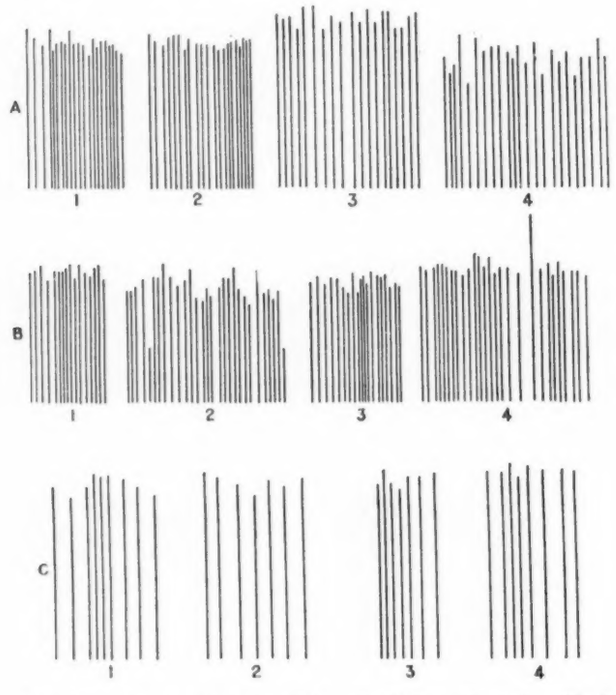


Fig. 2—Charts show working condition of each cylinder

were irregular with an occasional misfire and an occasional explosion taking place prematurely. Chart *C* which was taken recently, shows all four cylinders to be evenly adjusted. This same practice of checking the pressures is also used on a number of air compressors and helps to determine if both ends of the cylinder are working alike.

L. M. JOHNSON.

Sewickley, Pa.

Dead Power Lines May Be Dangerous

High-voltage equipment and overhead power lines may not be safe to touch or work on unless grounded. A long overhead line, even if it has never been connected to a source of power, may be dangerous, as the following incident will indicate:

Two men were inspecting a new plant that was practically finished. The transmission line was completed but had never been made alive, and the disconnect switches were open at the plant. Knowing that the system had never been connected to a source of power, one of them reached up to touch the line where it came into the plant. A small flash met his hand, accompanied by a sharp crackling sound, and he fell unconscious.

A static charge on the insulated line had caused the man to be so badly shocked that it required two hours to restore him to consciousness. Such a shock might well have proved fatal and shows that there is only one safe rule and that is not to touch electrical equipment unless it is known to be safe.

Overhead wires can become heavily charged from the static in the atmosphere, or they may have a high potential induced in them by the passing of a thunder cloud. If the potential is not high enough to break down the gaps of the lightning arresters, or get to ground by some other means, the line remains charged at a high potential, at least until the charge leaks over the insulators to ground. The electrostatic capacity of a long line at high voltages is high and may, if discharged through a human body, cause a shock that will produce death. Such lines when they are dead should always be grounded, so that any static charges that may be induced on them will have an easy path to the earth.

Baldwinsville, N. Y. ANTHONY J. CHRISTOPHER.

Can You Use the Ammonia Helmet?

At one time I was assigned the duty of showing an insurance inspector around our plant, which contained a 50-ton and a 25-ton ammonia compressor. During the course of inspection he asked me if the plant had an ammonia safety helmet and where it was kept. I showed him the location alongside the chief's desk and was suddenly struck by the thought that he might ask for a demonstration. Not until that moment had it ever occurred to me that neither I nor any other operator had ever tried on the helmet, and I felt sure we were in for sharp criticism from the inspector. However, he merely picked up the helmet and after one glance placed it over his head and pulled up all the straps. After pronouncing it in proper condition he continued his inspection without asking any questions that would reveal my ignorance on this vital subject.

When he had gone I lost no time in familiarizing myself with the use of the helmet, following the printed directions that were supplied with the outfit. After a few trials I could don it in quick time, and with a little practice I was able to adjust it so that it was leakproof. I was asked the why and wherefore of this sudden interest in the helmet by the rest of the crew and explained the situation as I saw it. The chief took the suggestion in good spirit, and every man was drilled in the art of quickly getting the helmet in place and properly adjusted. Some of them did not even know where it was kept. From then on we all had to put on the helmet once a week to prove our familiarity with it and its working condition.

This started another train of thought, and one man asked where the main ammonia liquid valves were located. It took a moment or two of thought before any of us could name the exact location of all valves, and when we went to close some of them we found that our knowledge of the plant was rather below par for experienced operators. A well-defined plan of action was laid out on a chart by the chief, and after a little practice we were letter perfect in all the safety precautions. But I dislike to think of the consequences had an accident such as a pipe failure occurred previous to the inspection.

Instances have occurred when an ammonia leak found the engineers unprepared to locate and close the proper valves. The loss of a ton or so of ammonia is expensive and to avoid this all valves should be properly tagged, and the force schooled in the plant layout.

Thompsonville, Conn. G. H. HART.

Comments from Readers

Heat Transfer Through Wet Condenser Tubes

Mr. Andrews' speculation on "Heat Transfer Through Wet Condenser Tubes," *Power*, Dec. 28, 1926, page 981, brings up a number of points well worth attention in spite of the fact that many engineers will undoubtedly question whether he has contributed anything of value to the subject. As a matter of fact his two conclusions, both accepted practice in condenser design, are obvious and bear little or no relation to his theory. Placing the maximum amount of surface in the front line and distributing it so that steam strikes it with the maximum velocity, has been advocated many years.

Economic, manufacturing and installation factors prevent this being literally followed out, although two recent designs, Fig. 1, show an obvious effort in this direction. A number of things combine to make such designs advantageous, not the least of which are the desirability of low pressure drop through the condenser and the effect of the steam velocity in keeping the tubes from becoming airbound.

Published tests show average heat transfer coefficients of 600 to 800 B.t.u., the latter for a condenser with about 12 per cent of the total surface in the first three rows of tubes. That these few tubes carry most of the load with average heat transfer as high as this is improbable. Furthermore, test results carried out in connection with a new single-pass condenser, Fig. 2, showed

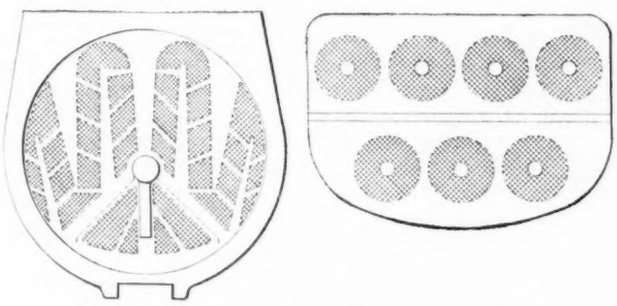


Fig. 1—Two examples of condensers with extensive front-row surface

that the temperature rise in various parts of the condenser differed only a fraction of a degree.

Again, by taking a piece of gage glass and holding it under a faucet opened just enough to give a smooth stream, flow as in Mr. Andrews' Fig. 1 is obtained. A glass tube drawn down to a fine tip can be used to introduce a small stream of potassium permanganate and show that the circular convection currents shown in his illustrations do not exist.

In fact Mr. Andrews' assumption that gravity and friction produce a couple is a fallacy. The flow in this case is similar to that in an open channel in which it has been definitely proved that the flow takes place in layers gradually increasing from nearly zero at the bottom to a maximum slightly below the surface.

Heat transfer may increase with the thickness of the water film, but if it does it is in direct opposition to Mr. Andrews' theory, because common sense as well as simple experiments show that the thinner the water film the greater the tendency to turbulent flow or the production of eddy currents within the film.

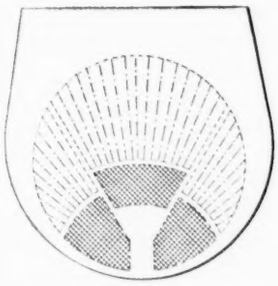


Fig. 2—A condenser that showed uniform temperature rise throughout

I have been actively interested in condenser design for many years and have followed the experiments of Frost, MacAdams, Orrok, Sherwood and others with a great deal of interest, but I must admit that I can see nothing in any design, test or experiment that substantiates Mr. Andrews' views.

F. BRIGGS.

St. Petersburg, Florida.

Life of Metallic Packing

On page 138 of the Jan. 25 issue of *Power*, A. H. Halladay tells of a set of metallic packing on the piston rod of a hoisting engine that has been in service twelve years last August. That is a good record, but I can go him one better.

On Aug. 25, 1907, I put a set of floating metallic rings on the rod of a 12x30-in. Bates Corliss engine direct connected to a Wolf Linde ammonia compressor in the Fresno Brewing Co., now known as Fresno Beverage Co. The rod is 2 3/16 in. in diameter and the engine runs at 65 r.p.m. and averages better than 12 hours per day for 365 days of the year. The rod is as smooth as glass and packing as tight as ever. I had one set of new garter springs put in some four or five years ago.

On account of the construction of the crosshead guides and piston, I could not make the rod run true and soft packing would blow in a few days after putting in, but the floating rings ran perfectly tight and are still doing so. Figuring 65 r.p.m. for 12 hours a day gives 85,410,000 ft. of rod travel per year.

Fresno, Calif. E. C. CUNNINGHAM, Engineer,
Fresno Beverage Co.

I think I can beat the metallic packing record of A. H. Halladay. At the plant of the McLean Coal Co. there is a 20x36-in. Corliss operating at 120 r.p.m. and with a steam pressure of 110 lb. gage, that has been in service eight hours a day for over eighteen years, and the packing appears as good as new. The piston rod on this engine is 4 in. in diameter. Outside of rebabbitting the lower crosshead shoe once and renewing the small plates on the cutoff hook occasionally this engine has had no repairs of any kind.

The secret of long life to metallic packing is positive lubrication, and it has been my experience that about one drop of cylinder oil per minute on the piston rod is about right. The piston travel of this engine is approximately 103,000,000 ft. per year.

Bloomington, Ill. FRED THOMMEN, Engineer, McLean Coal Co.

Water-Power Policies

The Foreword by Mr. Low entitled "Water Power Policies" in *Power* for Feb. 1, has come to my attention.

I do not question your privilege as the editor of a technical magazine to champion one side or the other of a political argument. I happen to disagree with you with respect to the advisability of the creation of the Water Power Authority recommended by Governor Smith. I assume that you are an exponent of the proposed Power Authority because you think that the Governor's hypotheses are correct, and that you think that if the situation is as the Governor claims it to be, his solution is the correct one. I do not think so for the following reasons:

In the first place it seems utterly futile to carry on this discussion as to what to do with the tremendous water-power resources of the State of New York when as a simple matter of fact no one knows whether the State of New York actually owns any water power that amounts to much. It just so happens that I was connected with the New York State Water Supply Commission twenty years ago, when substantially the same argument was going on as is now consuming the public attention to the detriment of the interests of all concerned. During the time that I was connected with the State Commission we spent several hundred thousand dollars investigating water power and recommending what ought to be done about it. One thing that we learned was that the state's holdings of riparian lands with appurtenant water powers in the Adirondacks are decidedly limited. Almost without exception it has been the state's policy to acquire land in the Adirondacks at a minimum of expense. This policy has resulted in the acquisition of large areas of burned over lands, mountain tops, swamp areas and tracts that have been stripped of all timber that had any commercial value. These areas are largely in the headwaters of the Adirondack streams. Generally speaking, the tributary drainage areas are, therefore, small and the volumes of water are not of sufficient magnitude in many cases to justify the development of the water powers.

By the time these streams accumulate sufficient drainage area to make water-power developments worth while, they are out of the state owned and into privately owned lands. I should be quite willing to risk my reputation as an engineer on the statement that the state does not own water power in the Adirondacks that is commercially feasible of development to the amount of as much as can be produced by one of the recently installed waterwheels at Niagara Falls. I, therefore, think it is perfectly safe to say that the state does not own any water power in the Adirondacks that is sufficiently important to divert the attention of our public officers, legislature and the people from the much more important public problems that already confront them. I believe that Governor Smith realizes that this is a fact and is now concentrating his entire energies in the water-power controversy on the St. Lawrence River.

As to the St. Lawrence River, you probably know that the State of New York two or three years ago started an action that gave promise of disclosing whether the federal government or the state owns the water rights on the St. Lawrence and Niagara Rivers. That action was quashed for reasons that I shall not attempt to enumerate. Meanwhile the Niagara Falls Power Company is paying the United States government about $86,000 a year in recognition of the federal government's right to lease the waters on the American side of the Niagara Falls. At the same time the Ford Motor Company is paying the United States Government $5,000 a year rental for the water at the Green Island Power Plant at the Troy Dam on the Hudson River. The Hudson River is, of course, recognized as a navigable stream over which the federal government has jurisdiction, although it is not an international stream as are the St. Lawrence and Niagara Rivers.

In the next to the last paragraph of your editorial you refer to the possibility of furnishing power at cost to the consumer. Can it be possible that the publishers of our most prominent technical magazines do not realize that the major part of the cost of power that might be brought from the St. Lawrence River to the ultimate consumer would consist of the cost of transmission and distribution and that the cost of St. Lawrence River power at the switchboards of the power plants, however cheap, could not possibly have any measurable influence on the electric bill of the average citizen. Let me give you an illustration as to how it might work out.

As a citizen and home owner in Syracuse the electric bill that has just come to my desk today shows that I pay $7.60 for 120 kw.-hr. of electric current. This amounts to 6.3c. per kw.-hr. I get my electricity from the Syracuse Lighting Co. They get it from the Niagara, Lockport & Ontario Power Co., which in turn buys about 50,000 kw. from the Niagara Falls Power Co. at Niagara Falls. During the year 1925 the gross receipts of the Niagara Falls Power Co. divided by their total kilowatt-hour output amounted to 0.3c. Assuming that the Niagara, Lockport Co. pays them this average rate for power and assuming that the generating company, the transmission company and the local lighting company should by some inconceivable arrangement secure the power that comes from the Niagara Falls Power Co. for nothing, what would the obvious effect be on my bill? Apparently, if the entire saving were passed on to me my bill would be reduced from 6.3c. per kilowatt-hour to 6.0c. and my saving on a two month's electric bill would be 40c. on a bill of $7.60.

If this is true, then what practical sense is there in the continuation of the political discussion about water power in New York State? Would it not be better for the state authorities to move, first to secure a determination as to whether the state or the federal government owns the American side of the St. Lawrence and Niagara Rivers?

The state has to my personal knowledge spent not less than one-half a million dollars investigating water power and during the time politicians have been quarreling about it, private and corporate owners have been proceeding with developments as rapidly as the demand for power has required, with the result that many of the power sites that were discussed in our reports of twenty years ago are now developed and in service and no longer open to discussion. There are available in Albany volumes and volumes of reports, estimates of

cost of power developments and storage reservoirs and transmission lines and case after case full of maps and plans resulting from elaborate surveys that have been conducted by state commissions from year to year during this long drawn out discussion of what ought to be done about water power. Meanwhile as you, the publishers of the world's foremost technical papers most certainly know, the average price of electric energy to the ultimate consumer is lower today than it has ever been before.

Personally, I should be highly pleased to learn that the State of New York and not the Federal Government, owns the water rights in the St. Lawrence and Niagara Rivers, for I have had a professional interest and share in the development of water powers in this state for the last twenty years. Furthermore, being a citizen of the state I should be glad to learn that I am a stockholder in the St. Lawrence and Niagara Rivers' water power, but even if I eventually discover this to be a fact, I certainly shall not expect to be able to buy my electricity materially cheaper than I am buying it today.

DAVID R. COOPER,
Syracuse, N. Y. Hydraulic Engineer.

Unimportant Savings Sometimes Carry Most Weight

In many industries the cost of power is a very small part of the cost of the manufactured article, and in the plants of these industries the engineer usually has considerable difficulty in arousing interest in the management for any money-saving plan in his department.

However, let me cite a case where the chief engineer got his plan across by centering his attack upon the company's payroll, its most vulnerable point, and showing the management that he could literally cut dollars from it. Although this plan is not generally adaptable, the conditions may be comparable to those of many factories in which the engineer and his force are considered the least important department.

This organization felt that it was extravagant to pay more than the minimum wage for firemen, despite anything the chief could say to the contrary and, of course, always obtained the poorest kind of men.

The plant's return-tubular hand-fired boiler was run on two twelve-hour shifts, and during the winter it was just about impossible to hold a man on the job more than a week or two. Every man made the same complaint; the boiler was overworked and it could not hold up the pressure. The engineer was continually breaking in new firemen, such as he could find at the wage figure he must not overstep, and naturally had many queer cases to handle.

One of the firemen carried a very deep fire, and even by the application of a number of his private tricks, which he claimed had made it possible for him, in the past, to hold steam on many an overworked boiler, he was unable to hold the gage at the right point. At each cleaning he turned the hose into the firebox to cool the ashes he was about to remove, which hastened cleaning and made the task more pleasant and would have given him a rest while the walls were being repaired, had he stayed long enough. His successor received the rest. During the two weeks this man was with the company he ruined four slice bars by heating and bending.

Another man always allowed his water to go out of sight while cleaning. This boiler was not equipped with an automatic feed-water device, but the pump was run continually at a speed that kept the level just about constant. He shut the pump off while cleaning, so as to save steam at the expense of lowering his water level, and with the clean fire ran the pump faster to get the water up to the regular level.

I have always been surprised that the fusible plug never blew out during this operation, for it was common, during his short stay, to see the water leave the glass quite a while before the cleaning was finished.

This changing of firemen went along for some time, one man after another, the majority of whom stayed only long enough to feel the heat of the fire, and this entailed the added expense of having a higher paid man from the machine crew act as fireman until another was secured.

In this last was the chief engineer's chance of showing a saving in the payroll. By cutting the number of times a much higher paid man need be called to substitute, he could actually show that the excess over the regular fireman's wage, paid substitutes during several months, would be a little more than sufficient to pay a better man a higher salary. This was enough to gain the management's consent to allow the higher wage.

The least important saving in this case carried the greatest weight with the management, which is so likely to happen when the business man is asked to consider some of these technical reports many engineers are so fond of placing before them. A saving in efficiency, for some reason, rarely carries the weight with the management of this type plant, that the more easily seen saving, however small, in payroll does.

The fireman who finally filled the bill understood the principles of hand firing and apparently had no trouble in holding steam all the time. He fired by the coking method and always kept a clean fire and a constant water level. In other words, he knew more than just shoveling coal and slicing the fire. He used his head and took advantage of the experience he had had, and he was worth considerably more than they paid him.

Arlington, N. J. RAYMOND L. DREW.

Why Is the Vacuum Low?

After reading several articles in *Power* on "Why Is the Vacuum Low," I will tell of some experience we have been having during the time these articles were being published.

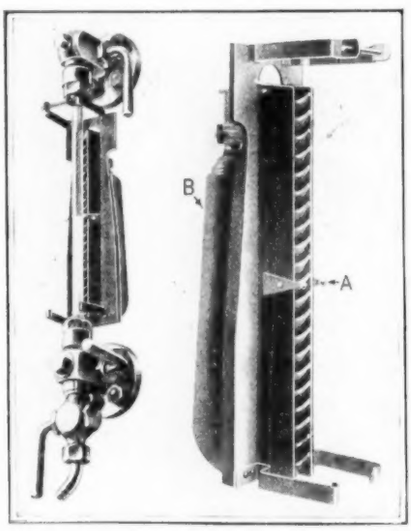
We have a 5,000-kw. turbine with a bleeder heater connected between the intermediate- and low-pressure blading. When we cut the heater out, the vacuum would go down; when cut in again the vacuum would come up. We were some time trying to figure this out. One day we found a gasket leaking at the expansion joint on the line to the extraction heater; this was repaired and no more trouble was experienced for some time, then the vacuum went down again. Of course we looked for leaky gaskets and broken expansion joints, but found none. We put new nozzles in the air ejector, but with no success. After some days of trouble hunting, we decided that a gasket was leaking on the air ejector between the raw-water pass and the condensate pass. After removing the water-boxes, we not only found the gasket gone, but two tubes out of the sheet on the raw-water pass. This was repaired and the vacuum restored to normal again, which is an exhaust temperature of 74 deg. F. and a 29.1-in. vacuum.

Aberdeen, Wash. H. H. FINCH,
Chief. Eng. Power House.

New and Improved Equipment

Illuminating Water Gage Fitting

To facilitate seeing the water level from a considerable distance and at any point in the gage glass the illuminated fitting, illustrated, has been introduced by Babcock & Wilcox, Ltd.,



Illuminated fitting adaptable to round and plate glass gages

Glasgow, Scotland. The important feature in the design of this fitting is that the light rays of an ordinary electric lamp are collected and reflected onto the gage glass in such a way that the top of the column of water, or meniscus, is brilliantly illuminated under practically all conditions for the full length of the water column. The working level is indicated by an illuminated red signal *A*.

The fitting can be readily attached to or removed from the water column, and is not damaged when a gage glass breaks. It is also applicable to the plate-glass transparent type of water-level indicator as used on boilers operating at high pressures.

Auburn Heavy-Duty Stoker

A line of semi- and full-mechanical stokers for all types of boilers has been brought out by the Auburn Stoker Corporation, of Auburn, Ind. The heavy-duty stoker has mechanical timing elements for the operation of the stoking bars at regular intervals and an adjustable coal feed for regulation of the supply of fuel in proportion to the load. It may be operated on natural or forced draft. A feature facilitating erection is complete assembly of the stoker, with the ignition arch, at the shop.

Figs. 1 and 2 show the full-mechanical stoker, designed so that it is possible first to install and operate the grate as a hand-fired stoker equipped with operating levers to work the stoking parts by hand. Later on, the automatic fuel feed may be added to produce the semi-mechanical stoker, and finally the addition of the automatic timing element for the manipulation of the stoking bars gives the full-mechanical stoker.

The mechanically operated pushers are provided with micrometer adjustment to change the quantity of coal fed while still retaining the same time element in the operation of the stoking bars, this being necessary as both the pushers and the timing elements are driven by the same motor. Air preheated by the ignition arch is distributed through a fluted arrangement back of the coal hopper across the entire width of the furnace.

Advance of the coal along the grate is effected by stoking timers consisting of two ratchet wheels mounted on a carrier bolted to the stoker front. Twin pawls, carried on pawl arms keyed to the main shaft, operate in unison with the strokes of the driving motor. An individual timer is provided for each set of alternate stoking bars in each section of the grate with a rod extending from the timer arm to the connecting bar of each series of grate bars. These timers are set to operate each series of stoking bars at regular intervals, one after the other, and the duration of these intervals may be varied by the adjustment of a valve controlling the driving motor. The reciprocating motion of the timers rotates the bars through an arc of about 90 deg. and immediately returns them to their normal position.

A wide dump grate, counterbalanced to allow easy operation and to prevent clinkers interfering with its return, permits the disposal of large clinkers without the necessity of breaking them up. Back of the dump grate a dead plate is provided to lock together the bearing bars of the stoker and to prevent clinker formation on the bridge wall.

To the rear of the last active grate

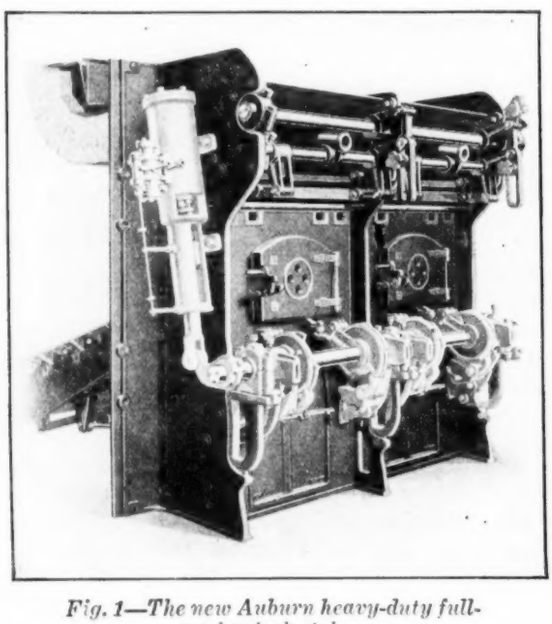


Fig. 1—The new Auburn heavy-duty full-mechanical stoker

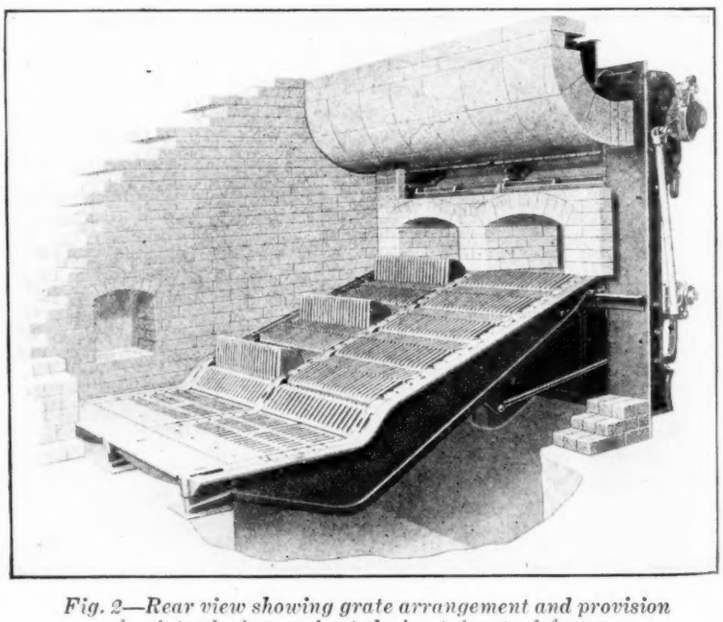


Fig. 2—Rear view showing grate arrangement and provision for introducing preheated air at front of furnace

bar in each stoker section, a stationary grate is sloped at a considerably greater angle than the others to insure covering the dump grate with fuel immediately after it has been dropped in cleaning fires. The purpose is to minimize the amount of excess air entering the furnace.

Each stoker has its own individual motive power. For the full-mechanical type the individual hydro-motor is used. This consists of a hydraulic cylinder with a simple valve control, operating at a speed of from ½ to 8 strokes per minute and driving both the coal feed pushers and the stoking bars.

Provision is made to operate by hand either the hopper coal feeding arrangement or the stoking bars, should this become necessary. Furthermore, the stoker may be fired by hand through the emergency firing doors provided.

Using Disk-Arm Valves as Pump Check Valves

A difficulty with large check valves of the conventional design, when used in the discharge of pumps, is that they are likely to slam shut and cause serious water hammer. To provide a check valve that can be controlled during its closing and opening operations, the Coffin Valve Co., Boston, Mass., has developed a new type of control for its

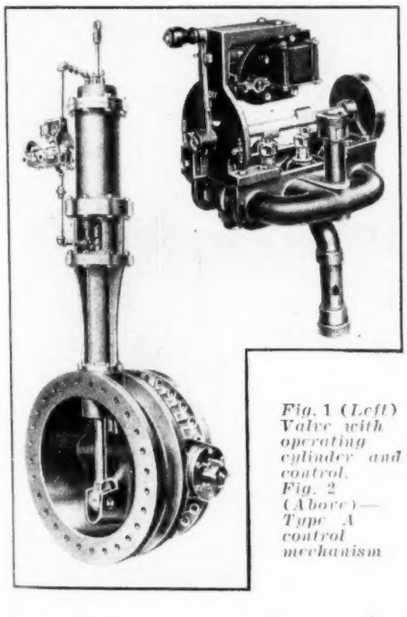


Fig. 1 (Left) Valve with operating cylinder and control. Fig. 2 (Above)—Type A control mechanism

hydraulically operated Dow disk-arm pivot valves so that they can be used as check valves in the discharge lines of pumps. For this service pivot valves of standard designs are used. In sizes up to 36-in. they are designed for 300 ft. head and in the larger sizes for heads of 150 and 300 ft.

Three types of control have been developed. Opening of the valve with type A control, the control is operated manually, but closing is made automatic by de-energizing a solenoid connected to the motor terminals. This form consists of four quick-opening globe valves operated by a camshaft, which can be turned by a crank, as shown in Fig. 2. The action of the four globe valves is the same as a four-way cock and allows the pressure to go to the opening or closing ends of the hydraulic operating cylinder, shown mounted on a valve in Fig. 1. To have the hydraulic cylinder open the valve, the crank is moved to the open position and is held in this position by a solenoid actuated latch. As long as the solenoid is energized, the valve will remain open. Interruption of power to the solenoid causes it to release the latch, and the camshaft springs back to the shut position automatically, causing the valve to close.

The type B control mechanism functions to open the valve automatically when a solenoid is energized at the time the motor starts the pump, and closes the valve automatically when the solenoid is de-energized. This provides a means of automatic remote control of the valve. With this type the control valve is of the plug type with a sleeve that is moved up and down by the actuating mechanism. The movement of the sleeve uncovers ports connecting the hydraulic pressure to either the closing or the opening ends of the operating cylinder.

Both types of control referred to move the valve either to the full open or to the closed position. For use when it is desired to hold the valve in a part-open position, the type C control has been developed. The control valve for this type is of the same design as for the solenoid operated type. In the latter case the valve is set by hand to the desired position, and it will close automatically when the power to a solenoid is interrupted. In all types the solenoid is connected to the pump-motor leads, so that as soon as the pump is shut down, the solenoid on the valve control becomes de-energized and the valve closes automatically, giving the same action as a check valve, except that its rate of closing is regulated by the control and it cannot slam shut.

Automatic Alternator for Duplex Vertical Pumps

The Chicago Pump Company, 2336 Wolfram St., Chicago, announces that an automatic alternator, designed to alternate the operation of each pump in a duplex unit, has been added recently to the Chicago vertical centrifugal pumps, particularly sewage-ejector and bilge-pump equipment. The alternator operates so that the work is shifted automatically from one pump to the other in a one-two method, without the equipment being touched by an operator.

In addition to alternating the operation of duplex equipment, the alternator automatically starts the pump not in operation in the event that the one in operation fails or is not able to handle all the water. During an emergency or flooded condition both pumps will cut in automatically and continue to operate until normal conditions are restored, at which time they will resume their alternate operation.

Enco Pulverized Coal Burner

A pulverized coal burner of the turbulent type, brought out recently by the Engineer Company, New York City, is illustrated herewith.

The pulverized coal is admitted through a circular chamber having

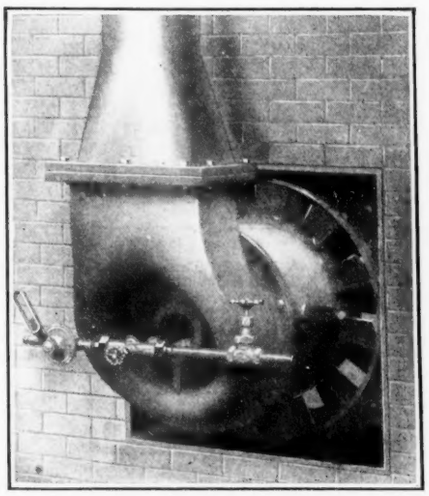


Fig. 1—Pulverized coal and oil burner combined

spirally inclined vanes that give it a clockwise whirling motion, while the secondary air is admitted around the coal stream with a counterclockwise whirling motion. The effect of these streams being brought together from opposite directions is to give intimate mixture, turbulence and a short flame.

The burner is designed to permit the pulverized coal to be fed at a low

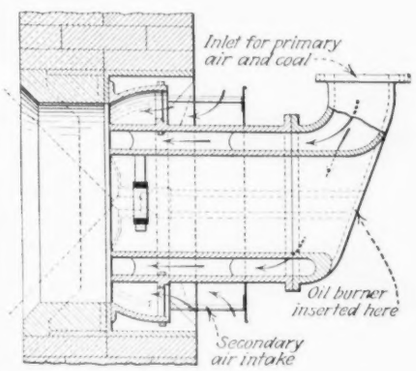


Fig. 2—Cross-section of combination type burner

static fan pressure and to operate on either natural or forced draft and with either coal or preheated air. It is also arranged for use in combustion with gas or oil, provision being made for the supporting of the oil or gas burner in the center, as shown by dotted lines in Fig. 2. Any of the three fuels can be burned separately or all three in combination without change in the apparatus.

Rolling Tubes in Boiler Plates*

The Strength of Rolled Joints, the Power Required To Roll Them, and the Effect of Rolling on the Metal of Both Tube and Sheet

By P. H. OPPENHEIMER, Dr.Eng.
Design Engineer, American Brown Boveri Electric Corporation

TUBE fastenings in boiler plates must meet two requirements: First, they must make a tight seal between fire and water, and secondly, they must withstand certain stresses that occur in all boilers under operating conditions due to the unequal expansion of the tubes and tube sheets. In certain types of boilers, such as the vertical water-tube type, the stresses due to the weight of drums suspended from the tubes must be added.

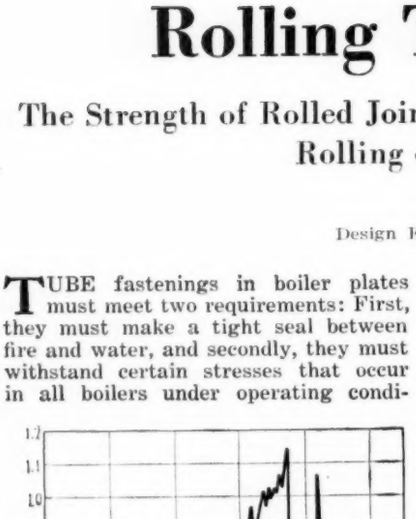


Fig. 1—Power for rolling tube and withdrawing expander

In principle a tube expander consists of three parts: A conical pin, an odd number of rolls, and a socket guiding the rolls. The task of the tube expander is to press the rolls radially against the inner wall of the tube by advancing the conical pin and to roll the tube on its entire periphery as the pin is turned.

Test Arrangements

Experiments were conducted with tube expanders driven by a slow-speed electrical boring machine. The power input to the motor of the boring machine was measured by a recording wattmeter. Fig. 1 represents a diagram of the input to the motor obtained in this manner.

This diagram shows that the process of rolling is composed of three operations:

a. Expanding the tube until it touches the wall of the hole in which it is being fastened.

b. Rolling the tube and deforming the metal of the plate surrounding it.

c. Withdrawing the expander.

In expanding the tube (period *a*) the power input increases in proportion to the number of turns made by the tube expander. In Fig. 1, it will be noted that as soon as the tube touches the surrounding metal, the power required increases rapidly, fluctuating widely to a maximum reached at the moment the motor is switched off. In period *b* the so-called rolling of the tube takes place.

Tube rolling is a complicated case of cold rolling. Whereas, in rolling plates the plate is between two rolls, the distance between which may be considered as constant during each period of rolling, the tube to be rolled is between one roll of the tube expander on the inside and the material of the tube plate on the outside, the latter being deformed by the rolling. The layers of metal immediately surrounding the hole are deformed permanently. The more remote layers support the inner layers and undergo elastic deformations.

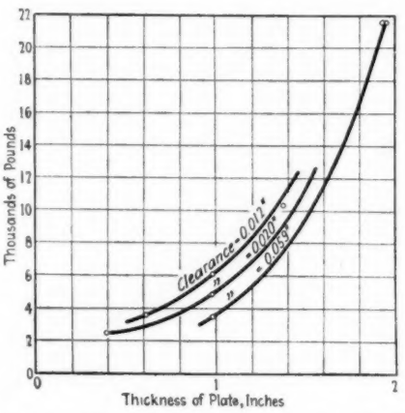


Fig. 2—Holding force due to shrink fit alone in relation to plate thickness

In the operation of the expander the pressure of each roll is transferred to the strip of tube metal in momentary contact with it. Most of the particles of metal flow in the direction of the tube axis, the direction offering the least resistance, causing the tube to elongate.

On both sides the tube is restrained from elongation by friction; on the inside, friction between the polished rolls of the expanding tool and the inner surface of the tube; on the outside, between the outer surface of the tube and the material of the plate. As the friction between rolls and tube is less than between plate and tube, the tendency to flow is greater on the inner surface of the tube than on the outer. The result is that the tube is more elongated on the inner side. By friction the tube carries along material on the brim of the hole in the plate in an axial direction. The value of this friction depends on the roughness of the tube and the hole.

Radial stresses arise in the tube and in the plate material surrounding the tube during the period of rolling, *b*. The radial stresses in the tube will be small if the end of the tube is well annealed and the clearance of the tube in the hole was small before expanding.

The harder the original material of the tube and the more it is hardened by expanding on account of greater clearance, the higher the internal stresses of tube and plate will be. When the tube expander is withdrawn, the pressure of the rolls disappears, the internal stresses are released, hence the tube and the surrounding material of the plate spring back toward the center until equilibrium is reached; that is, until the radial forces normal to the exterior surface of the tube become equal to the opposite forces normal to the surface of the hole in the plate. Thus by rolling the plate shrinks upon the tube. In contradistinction to the heat-shrunk method of fastening, in this rolled-shrunk method the hole diameter is equal to the exterior tube

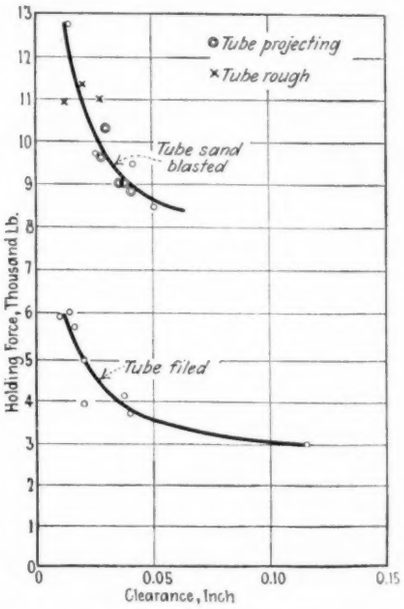


Fig. 3—Effect of clearance on holding force due to shrink fit alone

The lower curve is for tubes with the surface filed smooth, the upper for sand-blasted tubes. It is evident from both curves that the holding force increases considerably with decreasing initial clearance.

*Abstract of thesis of the same title.

diameter not only after having shrunk, but also immediately before shrinking. Thus the elastic shortening of the hole periphery is equal to the elastic shortening of the exterior tube periphery.

Analysis of the Holding Force

The holding force of a rolled tube against being drawn from the plate consists of the following resisting forces:

1. The friction between tube and plate due to the shrink fit.

2. In rolling a tube the part or end projecting from both sides of the plate is deformed more than the part of the tube within the hole. In loosening a tube projecting through the plate, the projecting end of the tube must be drawn through the hole of smaller diameter. This resistance may be increased by conical expanding, beading or rolling out by special methods.

3. The holding force is increased if it is necessary to shear parts of the tube or tube sheet to loosen the fastening. Such shearing occurs if a tube projecting through the plate is rolled very strongly or if the tube is rolled into circular grooves or with a turn of wire placed between the tube and tube sheet.

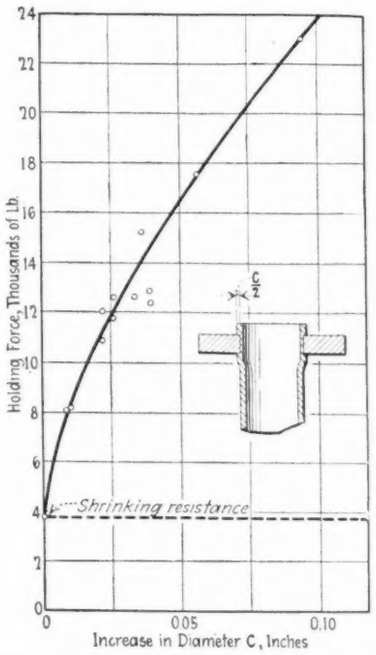


Fig. 4—Effect of projecting tube end on holding force

The average clearance is about 0.045 in. in diameter. The curve cuts the axis at 3,750 lb., the holding force due to the shrink fit for this clearance.

Results of Tests[1]

The material used for tests was new seamless boiler tubes and boiler plates, both of mild steel. Seven series of tests were made consisting of about 120 single tests. For each series of tests the pieces of tube were cut from the same tube if possible, while the flanges were cut by torch from the same steel plate.

[1]The tests were made by the author in the boiler plant of A. Rodberg A-G, and in the material testing laboratory of the Technical University, both in Darmstadt, Germany.

The results of the tests of the plate material were:

Yield point	= 29,400 lb. per sq.in.
Ultimate tensile strength	= 47,400 lb. per sq.in.
Elongation at rupture	= 28.1 per cent
Reduction of area	= 71.8 per cent
Brinell hardness	= 92 to 112
Carbon content	= 0.043 per cent

The results of tests on the tube material as delivered:

Ultimate tensile strength	= 59,000 lb. per sq.in.
Elongation at rupture	= 23.8 per cent

For the rolling tests pieces about 8 in. long were cut from stock tubes by a cold saw. The pieces were welded shut on one end over a mandrel turned to a hemisphere on the end. They were then heated in a charcoal fire and packed in ashes. After cooling, the scale was removed from the surface of the tube by sand blast or file.

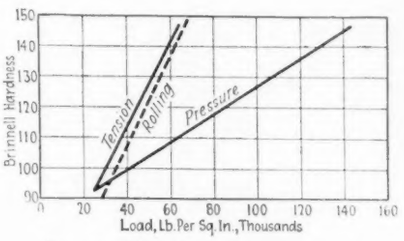


Fig. 5—Brinell hardness as an indication of stress sustained

The iron plates or flanges in which the tubes were rolled were 8 in. in diameter and were cut from the full plate by torch. Ordinarily, the boiler tubes used were of 3¼ in. external diameter and about ⅛ in. thickness (10 gage).

After being rolled, the joints were tested for tightness in an apparatus able to apply hydraulic pressure of about 3,000 lb. per sq.in. During the hydraulic test the tubes were hammered. After that the holding force of each tube was determined in an Amsler-Laffon compression testing machine. The tubes were pressed out of the flange by means of the mandrel over which they were welded shut.

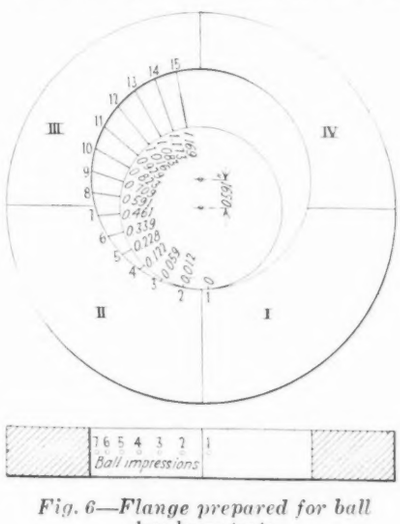


Fig. 6—Flange prepared for ball hardness tests

To determine the pure holding force of shrinking, the tubes were rolled while not extending beyond the plate. It was found by tests and also by mathematical analysis that the holding force of a shrunk fastening, the tube being simply rolled and not extending beyond the plate, depends on the following factors:

1. It is directly proportional to the coefficient of the slipping friction between tube and hole wall; that is, the holding force increases as the surface of tube and hole wall are rougher.

2. It is proportional to the thickness of the plate. The curve of holding force increases less rapidly in thinner plates and faster in thicker plates, as shown in Fig. 2, for different clearances between tube and hole wall before rolling.

3. It is a function of the amount the hole springs back after rolling, diminished by the amount the tube springs back. The elastic shortening of the tube after rolling is a direct function of the clearance between tube and hole diameters before rolling. See Fig. 3.

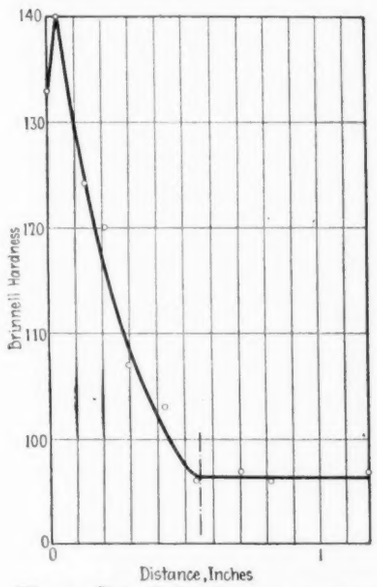


Fig. 7—Brinell hardness at various distances from tube wall

4. It depends on the ratio of external radius to thickness of wall of tube after being rolled. As long as the radius is changed in the same ratio as the thickness, the shrinking resistance is not altered. Of tubes of an equal diameter, those with thicker walls have a greater holding force. Of tubes of the same wall thickness, those of the larger diameter have a smaller holding force, but a tube of larger diameter must be rolled by higher pressure than a smaller one to be tight.

5. It depends on the ratio of pitch to diameter of holes after rolling. The influence of this factor is smaller than the diameter-thickness ratio and of practical importance only if the pitch is very small.

6. It is a function of the material of tube and plate and has its highest value if tubes and plates are of steel, and a smaller value if tubes are of steel and plates are of copper.

The power used for rolling has no influence on the holding force and the tightness of the shrunk fastening, after the power exceeds a certain minimum value depending on the diameter and the thickness of tube.

Holding Force of a Projecting Tube

In being rolled by a cylindrical expander with the tube end projecting through the plate, the tube is pinched over the diameter of the hole on both

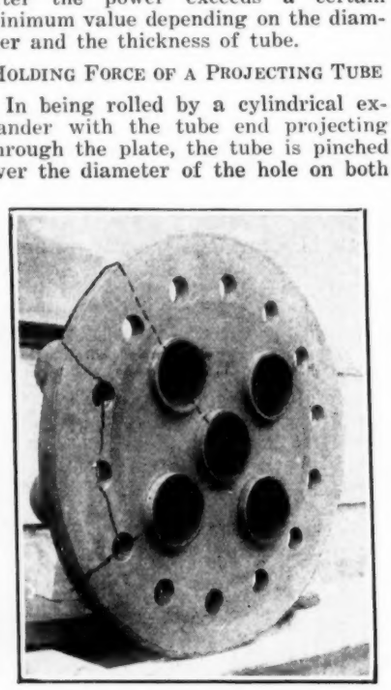


Fig. 8—Tube sheet with tubes rolled in

sides of the plate in a radial direction. By the resistance of these parts of tube against being drawn or pushed into the smaller diameter of the hole, the entire holding force is increased considerably.

In this case the shaping of the edges of the holes is of great importance. If the edges are sharp, the holding force does not increase as long as the tubes are rolled by normal power. Fig. 4 shows the holding force in relation to the radial projection of the tube end for filed tubes.

Increasing the Holding Force

The resistance of the projecting tube end can be increased by different methods, such as conical expanding, rolling by means of special expanders, and beading. For this it is very important that the material of the tube be as soft as possible and the ends of the tubes to be expanded be annealed most carefully. Although the material of the tube end is hardened in rolling by cold stretching, it must still be soft enough to bear the second process of expanding without splitting. The greater the angle at which the projecting end of the tube is expanded, the greater is the holding force. The maximum is reached in beading the tubes at an angle of 90 degrees.

When the projecting tube end is pinched over extremely, by using special expanders or by rolling with cylindrical rolls under very high pressure, the resistance of the tube against being drawn into the hole increases considerably, and the shoulder of the tube is sheared.

The most frequently used rolled fastening, based on shearing of the tube, is made by rolling into circular grooves. In this type of fastening one or several circular grooves are turned in the surface of the wall of the hole in the tube plate, and into these the tube metal is forced by rolling. By a great number of experiments the most advantageous type of groove was found to be one of square section having its inner corners rounded. All shear-type fastenings were tight under pressures up to 3,000 lb. per sq.in.

By rolling into one circular groove, the entire holding force is increased to 12 times the pure shrinking resistance of a filed tube, but this value was reached only when the groove was fully filled with tube metal. To do this, considerable rolling power was required and the deformations and the hardening of the tube and the boiler plate were considerably greater than in plain rolling. The shearing-type fastenings are not to be recommended for tube walls and boilers, but they are quite satisfactory for attaching pipe flanges.

A fastening following Lang's method of putting a steel wire between tube and wall of the hole is excepted. For this fastening no more power was required than for plain rolling, and the deformations were no greater than in plain rolling, while the holding force was nine times as much as the pure shrinking resistance of a filed tube.

Hardening of the Plate Material by Rolling

The object of the following trials was to determine to what degree the plate around the hole is hardened and how far the influence of the cold stretching extends.

Strain lines, recrystallizations and microscopic photographs of the material structure were adopted as qualitative methods of test and the Brinell hardness numbers as quantitative. By the latter method it is possible to determine the hardness in a comparatively small part of a body, while by the other mechanical tests the average properties of the material over a more or less large part of the body may be noted.

First, tests were made to determine whether the hardness numbers found by the Brinell ball pressure test give a real measure for pronouncing judgment of the hardening of the material by cold working.

A piece of the boiler plate used for the trials was reserved for the tests of the material, out of which three strips along the direction of rolling were cut. Two test pieces were machined to bars of round section and one to a bar of rectangular section. The elongations of the first round bar were measured by the usual method, those of the second round bar exactly by Marten's mirror extensometer. The third bar of rectangular section, having on both sides the black mill scale, was given a certain load in the machine for testing tensile strength, taken out and given two ball pressure tests, then put in the tensile machine again, given a higher load, taken out, given two ball pressure tests, etc., until the bar failed. Also small cylinders were turned from the boiler plate and each compressed by a different load. The hardness in the center of the end surfaces of each cylinder was determined in the Brinell hardness testing machine.

The results of these tests are given in Fig. 5. For comparison the dotted line found by A. Pomp is added, showing the increase in hardness of plates effected by cold rolling. From Fig. 5 it is evident that hardening does not take place before the yield point is exceeded. In the tensile tests, the pressure tests and the rolling tests the hardness is directly proportional to the loads divided by the momentary section (in the tensile test only until the area of the bar is diminished rapidly). The hardness increases faster by tension than by pressure. From this proportion and from the fact that the curve of hardness coincides with Ludwik's flow curve, it was concluded that the hardening of the same material by cold working is determined by the Brinell hardness numbers.

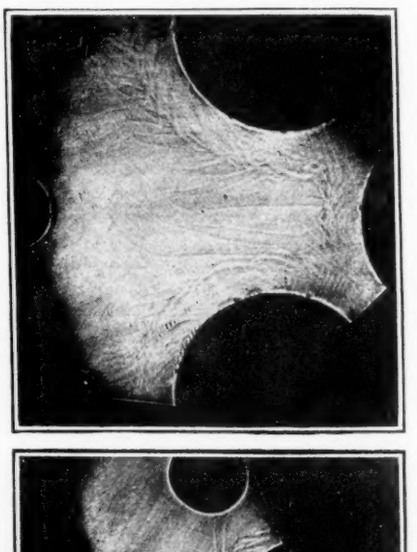


Fig. 9—Strain lines on face of tube sheets

Upper, strongly rolled series *B*; lower, normally rolled, series *A*.

To investigate the hardening of the plate material by rolling, the tube holes were turned out eccentrically and the flanges were divided into four parts by radial cuts as indicated in Fig. 6, so that the single pieces of plate could be tested conveniently by the ball hardness test. The distance of each point

of measurement from the original hole wall was found as shown in Fig. 6.

The curves of hardness, one of which is given in Fig. 7, are similar.

Reaching the greatest hardness at a small distance from the wall of the hole, they decrease rapidly to the value of the original hardness of the material. By this method the material of 15 flanges was tested in the vicinity of the hole, and it was determined that the hardening grows approximately proportional to the power required by rolling.

Inspection of Two Tube Sheets in Each of Which Five Tubes Had Been Rolled

How several tubes rolled in the same plate influence each other, is of special interest to the boilermaker. Therefore, two series of tests, *A* and *B*, were made. In each tube sheet of 16 in. diameter five 3¼-in. tubes were rolled, one in the center and four around it. Their location is evident from Fig. 8.

The average breadth of the bridge of plate between the central tube and the exterior tubes was ⅝ in. The tests differ only in the required rolling power, the average being in series *A*, 1.27 hp., in series *B*, 2.28 hp. To reveal plainly the strain figures, the front side of each tube plate was polished.

After the tubes had been rolled, the tube sheets had to undergo a hydraulic test at 625 and 710 lb. per sq.in. respectively. All fastenings in each group were tight. Especially, the center tubes were completely tight in both cases. The holding force of the tubes of plate *A* was found to average 9,400 lb., plate *B*, 27,400 lb. This difference has been explained in the preceding paragraphs by the fact that the ends of the tubes being pinched over the front edges of the hole in consequence of the strong rolling, must be sheared by the sharp edges of the hole in order to be withdrawn. The diameter of the tube wall *B*, which had been rolled strongly, had increased about 6 per cent, the diameter of the tube wall *A*, rolled with normal power, only about 0.9 per cent. Pieces were cut from each tube wall, following the dotted lines of Fig. 8, and heated to 570 deg. F. in a bath of oil. By this manner the strain lines (the so-called Lueders lines) appeared as shown in the photographs in Fig. 9.

It looks as if strings of strain lines run around the edges of the holes. In the narrow bridges of the tube sheet *A* the lines take the shortest way from edge to edge of the holes, while in the bridges of the tube sheet *B* strain lines cannot be distinguished, the material of these bridges being hardened entirely. Further investigations of the bridges between the holes by ball hardness tests, photos of structure and recrystallizations gave the same results, which are as follows:

As a result of rolling with greater power the material of the bridge between the tube holes becomes considerably different from the original material. It becomes more brittle over the whole section; that is, the hardness, yield point and tensile strength have increased, while the elongation has decreased. In other words, the material of the plate has become less qualified for bearing the continuous stresses of an operating boiler than it was originally.

The art of rolling tubes consists in producing a strong and tight fastening between tube and tube plate by using the smallest possible power. In the tests mentioned (diameter of tube 3¼ in., thickness of tube ½ in., thickness of plate 1 in.) the output of 1.1 hp. transmitted on the periphery of the pin, equivalent to a peripheral force of 800 lb. on each roll of the expander, has been proved sufficient.

To protect the tubes and the tube sheets in rolling, it is recommended that expanders be adopted which disconnect themselves automatically or give a signal as soon as a certain pressure is exceeded.

Power-Plant Maintenance*

Considerable space has been taken up in the technical press by discussions of plans used in systematic conditioning of station equipment, and each writer appears to have lost sight of the fact that maintenance has its origin in operation. Every system appears to be completely wound up in red tape that is either certain to become tangled up at times or soon become so automatic that the apparatus depreciates. It is quite possible to catalog some equipment and assign arbitrary schedules of inspection, but if this is broadened to cover all station apparatus, responsibility is gradually taken away from the operating personnel. Now a power plant is no different from any other manufacturing enterprise, in that interest and responsibility are so closely allied that the success or failure of any plan, either operation or maintenance, is in the hands of the operators. The operating crews must be the inspectors, and data taken by them used in reaching an understanding as to the condition of the station equipment.

In the Brooklyn Edison plants each piece of equipment in the stations is dismantled and overhauled during the year, and it is common knowledge that less system disturbance results where this plan is conscientiously followed through. In addition to the usual work done on a turbine during an overhaul period, every blade is regaged and interstage leakage is checked. The annual overhauling of a turbo-generator with its auxiliaries may cost from 3 to 10 cents per kilowatt capacity, varying with the size of the unit, but this expense is justified by the gain in operating economy and safety.

The major portion of the operating personnel have been brought up through the maintenance crew, therefore when equipment is turned over to their attention and care, the result is a continuous inspection procedure that is absolutely essential to successful production. Each turbine in operation on the entire system has a fixed load placed upon it at some time during the day, and a periodic check is made at full load with a complete set of readings taken in each case. This same plan is carried out in the boiler rooms, and it can be readily understood that the data so obtained are invaluable to the operating, maintenance and betterment divisions, in studying station performance, adopting methods to lower the cost of production with existing equipment and enabling a better understanding of losses that may be decreased by changes in operation, design or layout.

One other important operating factor still remains, one that has received too little attention both in the press and in the plant, and upon which we lay considerable stress, namely, good housekeeping. Its value, the author believes, is impossible of expression in terms of station performance, but its effect is in evidence nevertheless. The interest exhibited in one's job is largely dependent upon one's surroundings. If this is a fact, house cleaning should be a continuous rather than a spasmodic procedure.

*Abstracted from a paper by H. A. Cox, engineer of steam operation, Brooklyn Edison Co., read before the Metropolitan Section, A.S.M.E., Jan. 31, 1927. The paper will appear in *Mechanical Engineering*, and a limited number of preprints are available now.

Trent Process Applied to Rhode Island Anthracite

Mining of Rhode Island Anthracite at the Cranston mine will be resumed, it was announced recently by officials of the Anthracite Superfuel Company in Sockanosset, Rhode Island. According to Henry F. Maurel, vice-president and general manager of the company, the coal will be pulverized and treated by the Trent process, the resulting amalgam being finally baked to harden it and remove moisture.

Numerous attempts have been made in the past to use Rhode Island coal commercially, but these have met with little success, because of high ash, low volatile and great density. Not only is the coal difficult to ignite and keep burning, but the low fusion point of the ash, as well as its high percentage, results in numerous clinkers.

The process selected is designed to reduce the quantity of ash and also add enough volatile matter to insure easy ignition.

The natural coal is first finely pulverized in water, after which the entire mass is placed in a chamber where oil is introduced and the mixture violently agitated. As the mass is whirled about, the drops of oil collect minute particles of coal dust and separate gradually from the grains of foreign matter. The oil-coal amalgam, together with the water and ash, then flows to a drag classifier in which the amalgam is carried by scrapers up an inclined floor and separated from the ash and water.

The finished product is said to contain 92½ per cent of purified coal and 7½ per cent of combined fuel oil. It is the hope of the promoters that this fuel will find a ready market for domestic use in New England, as all the fuel now used there is imported from Pennsylvania or more distant points.

In view of failures of past attempts to utilize Rhode Island anthracite commercially, engineers are watching with interest the result of this latest experiment.

Use of Power in Steel Mills*

By WILFRED SYKES†

IN 1926, the United States produced in excess of 39,000,000 tons of pig iron as compared to a total world production approximating 76,000,000 tons. Out of a world production of 91,000,000 tons of steel ingots and castings the United States produced over 48,000,000 tons. Consumption of steel has increased rapidly. In 1900 approximately 360 lb. was used per capita and by 1926 this per capita consumption had increased to 930 lb. The total number of persons employed in the steel industry is approximately 470,000, and the annual amount paid in salaries and wages is between $850,000,000 and $900,000,000.

Development of the industry to its present magnitude has been possible only by using power-operated mechanical means to perform the numerous functions that in the earlier stages of the art were done by manual labor. In the middle of the last century the only power used at a blast furnace was for blowing. The filling of the furnace and the disposal of its products was all hand labor, and at that time furnaces had a production of perhaps 25 to 30 tons per day. With only a small fraction of the number of men that were employed previously, the production today runs from 700 to 800 tons of pig iron from a single furnace and at a much lower cost, in spite of the fact that wages have quadrupled. The same applies to the steel works and mills, so that it will be evident that the increasing growth of the steel industry has paralleled the growth of the power industry.

Industry Largely Electrified

At the present time the steel industry is largely electrified. About thirty-five years ago the electric motor made the modern traveling crane possible, and this was the first main application of motors in the steel mills. Gradually, the advantages of electric motors for other applications became obvious, and after a period of development of about fifteen years the electric motor has practically supplanted other sources of power for the various auxiliary drives used in the mills. At this time power was developed in various mills by direct-current generators driven by reciprocating engines. The units were usually small and frequently scattered in groups over the plant to limit the distance power had to be transmitted. With the development of turbo-alternators larger units became practical and the practice changed from the use of direct current to alternating current for generation and distribution, with rotary converters or motor-generator sets to supply the direct-current load and permit the retention of the direct-current motor, which was considered to have more desirable characteristics for the class of work involved.

FUTURE practice points toward the economical steam plant burning blast-furnace gas and interconnection with the central station for interchange of power. In general, the steel plant will not be justified in installing a generating plant unless thereby using fuel that otherwise would be wasted.

With the development of alternating-current distribution and the increase in size and improvement in economy of the generating unit it became possible to consider the use of electric motors for the main drive of the rolling mills. There were many mill engineers who were reluctant to give up the steam engine of heavy construction that had been developed for such work, but the advantage of generation in economical units at a central point, and the facility with which power could be transmitted with little loss, as well as the desirable characteristics of motors for many applications, inevitably forced careful consideration of electric drive and eventually its adoption.

Total Power Used in Industry

It is estimated that the total amount of power used in the industry in 1926 was equivalent to about 7,000,000,000 kw.-hr., approximately three-quarters of this being generated in the mills and about 25 per cent supplied from outside sources, largely from central-station plants. The approximate rating of motors used in steel mills is 3,500,000 hp., and of this total somewhat over 1,000,000 hp. are driven by purchased power.

About twenty years ago there was considerable interest in the development of gas-engine driven units, using blast-furnace gas having a heat value usually less than 100 B.t.u. per cubic foot. The development of gas engines in large sizes provided a more economical method of using this gas for power purposes as well as for driving the blowers supplying air to furnaces. After many initial difficulties gas engines were developed in this country that gave satisfactory operation, and were adopted quite largely for blowing and power purposes. While they were much superior in fuel consumption to the then existing steam-engine-driven units, they were more costly and more expensive to maintain and the capacity of individual units was limited.

In the meantime the turbine-generator was being developed rapidly, and with the use of higher steam pressure and superheated steam material improvement in economy resulted. The introduction of successful turbine-driven blowers for blast furnaces was an important factor in determining the method of generating power in the steel mills.

Surplus blast-furnace gas available for power varies somewhat with the furnace equipment and the type of blowing engine used. From 25 to 30 per cent of the total gas produced is used for preheating the air for the furnace. In a large modern furnace between 4,000 and 5,000 hp. is required for blowing air. There are a number of gas-engine blowers in use, and from a fuel viewpoint these are the most economical units at the present time. However, their first cost is high and the maintenance is considerably higher than with turbo-blowers. Modern furnaces require air volumes in excess of that which can be supplied by single gas-engine-driven blowers, which, in turn, increase the investment.

Increasing Use of Turbo-Blower

The latest development in this field is the turbo-blower. Its rapidly increasing use in the last few years is due to improved economy of the later designs and the possibility of building in a single unit any capacity that may be required in practice. With gas-engine blowers and efficient stoves the amount of gas available for power purposes will be approximately 55 per cent of the total. With a modern turbo-blower plant the amount of surplus gas for power purposes will range from 45 to 48 per cent.

It is characteristic of a steel-mill load that there will be considerable fluctuation in the demand for power and that there will be little correlation between the operation of the blast-furnace plant and the power requirements in general. In a fair-sized plant it will be found that the load factor on weekdays will run from 60 to 65 per cent, based on the maximum load, and that over a year the load factor will range from 45 to 50 per cent. It will be seen that this is not an ideal load for internal-combustion engines, as it is necessary that they should be operated near their rated capacity to obtain the best economy, and governing difficulties become serious with rapid load changes.

Where gas engines have been used, it therefore has become regular practice to install a certain proportion of the total capacity, usually about 30 per cent of turbine-generators, which are used to carry the peak load and help regulate the system so as to obtain a reasonably constant frequency. The over-all efficiency of such a plant is not very much in excess of that obtainable with modern turbo-generating plants, and in addition to the complications of the two different types of prime movers the combination costs much more than for an all-steam station.

In the modern turbo-generating

*Abstract of paper read before the Midwest Power Conference, Chicago, Feb. 16, 1927.

†Assistant to general superintendent, Inland Steel Co.

plants in the larger mills, units of 10,000 to 20,000 kw. are installed, and in many respects central-station practice has been followed, although the plants are usually simpler, economy being sacrificed somewhat to reduce cost. With a plant of this character it has been found that the surplus gas available is sufficient to produce approximately 250 kw.-hr. per ton of iron. This would be approximately sufficient to supply all power needs were it not for the lack of correlation between the blast-furnace and mill operations.

In many steel plants open-hearth furnaces have been equipped with waste-heat boilers which, with the gases at a temperature of 1,200 to 1,500 deg. F., will generate from 1,200 to 1,500 lb. of steam per ton of steel produced. As there are many uses for steam in a steel plant apart from power generation, usually it will be found that all the steam from the waste-heat boilers can be used to advantage.

The power required for driving rolling mills varies with the type of mill and its product. Many of the continuously running mills are driven by constant-speed motors, but there is an increasing use of adjustable-speed motors to enable mills to be run at the best speed for the particular product being rolled. With constant-speed motors the speed of the mill is usually a compromise between that required for the lightest and heaviest sections. Adjustable-speed drives allow better production in many cases. As alternating current is used almost universally for power purposes, various schemes have been evolved to obtain adjustable-speed drives, but all involve undesirable complications. There has been a tendency, therefore, in recent practice to use direct-current motors, either rotary converters or motor-generator sets being used to convert to direct current at the mill. Such drives are not quite so efficient as the various alternating-current combinations, but have the advantage of simplicity.

Many applications in steel mills can be taken care of with ordinary commercial motors, but most of the auxiliary drives around the mills proper have special mill-type motors. These auxiliary drives usually do not exceed 100 to 150 hp. in single machines. It will be found that the amount of power used for auxiliary purposes in the steel mills frequently amounts to one-third or more of the total power produced.

The present tendency regarding power development in steel mills depends upon the type of plant. In those plants with blast furnaces, it is believed that the future practice will be to install efficient steam-driven turboblowers and turbine-generators. Boiler plants will be developed to burn surplus blast-furnace gas economically and provision made for supplementary fuel where low-grade fuel is a byproduct in the plant, as for instance, coke braize. However, it usually will be found more satisfactory to burn solid fuels independently of the blast-furnace gas unless they are first pulverized. In some cases where blast-furnace gas is insufficient to supply the total power needs, pulverized coal will be used advantageously in the same boiler settings that have been developed for blast-furnace gas.

There will be a tendency to interconnect these plants with central stations, so that an interchange of power may be effected when the gas supply is insufficient or in excess of that required to meet the power demands. It is quite possible that an arrangement of this character can be worked out to the economic advantage of both parties concerned.

In the case of steel plants not having blast furnaces and located where central-station power is available, it is believed that power can be purchased to advantage when obtainable at a reasonable cost. The steel plant is justified in installing a generating plant only if it thereby uses the fuel that otherwise would be wasted. In general, it will be found that a steel plant is not justified in generating its own power unless this is the case.

American Boiler Manufacturers' Association

THE winter meeting of the American Boiler Manufacturers' Association was held at the Hotel Cleveland, Cleveland, Ohio, on Friday, Feb. 11, with President George W. Bach in the chair.

A report from the Association's representative to the Joint Committee on Feed Water with five other societies manifested the importance in which the boiler manufacturers hold this activity, but revealed nothing that has not been given to *Power's* readers in reports of the Joint Committee itself.

The Committee on a Standard Code of Practice Regarding Boilers and Accessories reported that it had been found impossible to standardize upon design specifications, especially for water-tube boilers, but efforts were still being made to arrive at uniformity with regard to connections and accessories. H. E. Aldrich, Jr., said that in relation to the standardization of suspension, it was proposed to make the maximum $\frac{L}{R}$ ratio = 120, the maximum allowable beam stress 1,500 and the maximum stress in hangers 10,000 lb. Attempts had been made to fix guarantees upon CO$_2$ and exit gas temperatures, but the revised specifications will involve more than this.

Mr. Broderick, speaking for the oil field boiler industry, said that the manufacturing problems are the same, but the marketing problem is different; activity in the oil fields is spasmodic; when a boom is on manufacturers rush in, make up a lot of stock that overlasts the demand and dump it at a loss when things slow down. The tendency to put up central-power stations in the oil fields was interfering materially with the demand for the typical oil-field portable boiler.

C. E. Bronson, of Kewanee, Ill., reporting for the Committee on Steel Heating Boilers, pointed out the handicap that such boilers are under in being subject to the expense of inspection during construction, whereas cast-iron boilers are required only to undergo a hydrostatic test after installation. This topic brought out considerable discussion, especially as to the situation in Massachusetts.

Homer Adams injected a needed note of optimism into the discussion. The use of boilers both for power and for heating is increasing. There is a good business in furnishing them. It may be true that the industry is overequipped, but the man who is best equipped both with machinery and experience and business sense and confidence can make a good living at it yet.

Brief progress reports were received from the Committee on the A.S.M.E. Boiler Code, the Stoker Committee, the Committee on American Marine Standards, the Committee on Welding of Pressure Vessels, the Committee on a Standard Method for Testing Structures under Pressure, and the Committee on Dished Heads.

In connection with the last-named topic the hearing upon this subject that will be held by the Boiler Code Committee at the headquarters of the American Society of Mechanical Engineers, 12 West 39th St., New York, on the evening of March 17 was announced. All those having interest, suggestions or experience in this subject, were invited to attend or send in communications, and a committee was appointed to represent the American Boiler Manufacturers' Association upon this occasion.

After luncheon L. Seth Schnitman of the Department of Commerce, Bureau of the Census, presented the appended results of a survey of the industry undertaken at the instance of the Association. While it was apparent that the results given were far from complete and that not all even of those present had responded to the call for information, the value of such a record, if it could be made sufficiently comprehensive, was acknowledged, and the association voted to continue its cooperation with the Census Bureau in developing it, and all present agreed to furnish the statistics asked for.

Considerable discussion followed upon the place of the modern power boiler in the rehabilitation of the industrial boiler plant. It was pointed out that the increase in rated boiler capacity has not been equivalent to the increase in power generated. Some of the reasons for this are the increased rate at which boilers are driven, and increases in the efficiency of steam-using apparatus both for power and heating and industrial processes. There is a limit, however, to the extent to which this forcing process can be carried and to the efficiencies that can be attained, and these two factors are likely to have less effect upon the demand for boilers in the future.

It was also pointed out that the returns upon the capital invested in public utilities had been falling off for the last two or three years, indicating that they had reached the limit of the amount of power load that they can take on below the cost of production and that their efforts are likely to be directed more to the profitable higher rate business than to displacing power plants that can justify their continued operation.

Appropriate resolutions were adopted on account of the death of Dr. J. T. Duryea, president of the Pierce, Butler & Pierce Manufacturing Co., of which the Ames Iron Works is a subsidiary; James Brown Stanwood, of the Stanwood Corp., and B. N. Broido, chief engineer of the industrial Division of The Superheater Company.

After considerable discussion as to whether the spring meeting should be held at White Sulphur Springs immediately following the meeting of the American Society of Mechanical Engineers in May or the week following at either White Sulphur or Hot Springs, the matter was left to the Executive Committee.

Results of Department of Commerce Survey on Steel Boilers

Washington, D. C.—Orders were received for 8,931 steel boilers during the first half of 1926 by 58 manufacturers, comprising most of the leading concerns in the industry, according to a preliminary report of the Department of Commerce, while shipments by these firms for the full year 1925 totaled 13,417 boilers, and in 1924 they shipped 12,215 boilers. More boilers were shipped in 1925 than in any other year since the end of the War up to that time, but in square footage 1920 shipments were the highest, followed by those of 1923. Of the various types of boilers reported, only steel-heating stationary boilers and Scotch-marine boilers showed increases over 1924 both in number and in square feet of heating surface.

The 58 reporting firms indicated that, on the average, between 1919 and 1925, 8,960 persons were employed in their boiler departments, 880 of these being in the executive, engineering or sales organizations, 7,210 in the shops and 870 in erection work. These firms used annually during that period 90,078 net tons of steel plate, 17,095 of structural shapes, 8,376 of bars, and 53,253 of tubes; they also reported 23,495 gross tons of castings.

The above table gives the number of reporting firms arranged in two groups: (a) According to the proportion of output shipped for export in 1925 and (b) according to the proportion of total money value of output in 1925 represented by the chief kinds of products. A few firms did not report on these items.

STEEL BOILERS

	Number of Firms Classed According to Proportion of Output Shipped for Export in 1925		Proportion of Total Money Value of Output in 1925 Represented by:			
Percentage Groups	In Number of Units	In Total Heating Surface	Boiler and Boiler Parts	Stacks, Breechings and Flues	Boiler Accessories	Tanks, Digesters, Etc.
None	38	38	2	9	17	16
1 to 10 per cent	7	9	8	24	22	13
11 to 20 per cent	6	4	3	8	10	5
21 to 30 per cent	2	2	4	4	3	5
31 to 40 per cent	..	..	2	3	..	4
41 to 50 per cent	..	..	0	4	..	1
51 to 60 per cent	..	..	6	..	..	3
61 to 70 per cent	..	..	4	..	..	3
71 to 80 per cent	..	..	4	..	..	0
81 to 90 per cent	..	..	10	..	..	2
90 to 100 per cent	1	1	9	..	..	..
Total	54	54	52	52	52	52

Liability of Employer for Injury by Employee While Temporarily Away from Work

By L. T. Parker

Recently, the higher Court of New Jersey (Pederson vs. American Smelting & Refining Co., 134 Atl. 672) held an employer not liable for an injury received by an employee (of another company) while he had temporarily left his work.

The facts of the case are that the accident happened on July 24, 1923. Thomas Pederson, the employee, was employed by John Pasky as an iron worker. The Barnett Company had installed a coal pulverizer for the American Smelting & Refining Co. John Pasky was employed by the Barnett Company to make some changes in the coal pulverizer. The employee had been working for John Pasky at the plant of the American Smelting & Refining Co. five or six days before the accident. On the day of the accident, he left his work to respond to a call of nature. He was directed by his foreman which toilet he was to use and the manner of reaching it. On returning from the toilet, he attempted to pass between an engine and a car temporarily detached, and was struck and injured by the moving engine.

The injured employee sued the American Smelting & Refining Co. for damages, but in holding the company not liable, the Court said:

"There were three ways by which he could have reached the toilet. There is no evidence in the case that would justify an inference of an invitation to go through the space between the car and the engine, so temporarily detached, where he was injured, nor is there any evidence that would justify an inference of a custom to so use such passage; at least he did not pretend to have any knowledge of such a custom. . . . He assumed the risk of injury. The injury to the plaintiff was not the result of any negligent act of the defendant."

STEEL BOILERS AS REPORTED BY 58 MANUFACTURERS

	Shipments														Orders Received	
	1919		1920		1921		1922		1923		1924		1925		First Half, 1926	
Type	No.	Sq. Ft.	No.	Sq. Ft.	No.	Sq. Ft.	No.	Sq. Ft.	No.	Sq. Ft.	No.	Sq. Ft.	No.	Sq. Ft.	No.	Sq. Ft.
Grand total	10,002	16,158,208	10,308	17,921,492	6,543	8,522,821	11,244	12,623,264	13,169	16,507,132	12,215	14,554,989	13,417	14,692,232	8,931	8,673,700
Stationary Total	8,887	12,352,142	9,847	16,406,077	6,312	7,565,382	11,131	13,386,146	13,099	16,386,146	12,087	14,273,369	13,272	14,458,753	8,837	8,528,961
Water tube	1,907	7,867,701	2,564	11,100,285	888	3,684,324	1,255	6,171,654	1,678	9,552,769	1,365	8,093,504	1,380	7,417,304	759	4,078,011
Horizontal return tubular	1,692	2,060,992	1,866	2,425,091	1,221	1,515,271	1,676	1,978,501	1,698	2,027,174	1,379	1,691,430	1,243	1,625,759	521	682,211
Vertical fire-tube	1,629	488,868	1,737	569,588	1,031	284,957	2,120	644,594	2,283	738,370	1,570	450,069	1,553	461,726	1,002	274,836
Locomotive (not railway)	451	207,562	529	246,140	232	120,506	374	215,361	530	269,371	417	209,824	342	154,397	210	102,980
Steel heating[1]	1,908	1,140,597	1,935	1,458,462	2,172	1,553,360	4,621	2,776,940	5,782	3,139,915	6,533	3,388,086	8,017	4,295,957	6,162	3,313,285
Oil country	1,024	507,380	703	442,333	621	363,573	923	548,895	879	575,627	535	319,412	477	386,840	23	7,430
Self-contained portable[2]	276	79,042	513	164,278	147	43,391	162	50,121	249	82,920	288	121,044	260	116,770	160	70,208
Marine Total	1,115	3,806,066	461	1,515,415	231	957,439	113	237,118	70	120,986	128	281,620	145	233,479	94	135,739
Water tube	821	3,125,687	169	810,144	99	667,410	50	164,049	16	46,581	67	229,754	52	134,823	25	76,925
Pipe	33	36,914	11	11,612	9	10,683	7	8,286	12	16,338	8	7,180	11	11,909	4	872
Scotch	244	636,695	261	681,976	102	269,418	34	55,061	22	45,238	35	37,081	63	75,031	53	48,478
2 and 3 flue	17	6,770	16	10,760	17	8,670	16	6,660	14	5,770	16	6,800	15	8,170	10	7,100
Miscellaneous			4	923	4	1,258	6	3,142	6	7,059	2	805	4	3,546	2	2,364

[1] As differentiated from power boilers.
[2] Not including types listed above.

News in the Field of Power

Failure of Bids Will Reopen Shoals Debate in Congress

A reopening of the whole question of the operation of Muscle Shoals is forecast with the situation where it was when the government first sought bids from private sources.

Industrial chemists declare the crux of the issue is that progress has put the Muscle Shoals cyanamid process out of date. F. A. Ernst and M. Sherman, experts at the United States Fixed Nitrogen Research Laboratory, in a world survey, just published, show that the newer method of taking nitrogen for fertilizer from the air by a direct synthetic ammonia process is proving cheaper and easier than the cyanamid process in which the government invested millions in Muscle Shoals during the war.

An engineering analysis of the Farmers Federated Fertilizer Corporation's offer for the Muscle Shoals development was transmitted to the Senate on Feb. 14 by the Department of the Treasury.

More Technical Study Favored

The analysis was prepared at the request of Senator McNary (Rep.), Oregon, chairman of the Senate Committee on Agriculture and Forestry, by the Engineering Division of the Income Tax Unit. In his letter of transmittal Secretary Mellon states that this analysis has been prepared along the same lines as were followed in the preparation of previous analyses of offers for Muscle Shoals submitted by the Air Nitrate Corp., the American Cyanamid Co. and the Muscle Shoals Fertilizer Co. No recommendation was submitted by the Department of the Treasury.

As this issue goes to press it is learned that the Senate Committee on Agriculture favors another study of Muscle Shoals by a joint congressional commission. In view of the failure of previous commissions to impress Congress, it is felt by many members that any investigation to be made during the interim between the adjournment of the present Congress and the opening of the next regular session, should be divorced as far as possible from politics and should provide for technical advice.

Fitkin Utility May Control West Missouri Power

The Missouri Public Service Co., one of the Fitkin utilities group, has filed application with the Missouri state public service commission for approval of the transfer of all properties of the West Missouri Power Co., valued under a recent appraisal at $6,500,000, to the Fitkin interests.

The properties being sold include generating stations, transmission and distribution lines supplying electricity, gas and water to fifty-six cities and towns in western Missouri, including Warrensburg, Holden, Odessa, Nevada, Clinton and virtually all of the smaller municipalities within a radius of ninety miles south and east of Kansas City.

Pennsylvania R.R. Plans Big Mutual Plant, Report Says

From unconfirmed Philadelphia news sources comes the report that the Pennsylvania Railroad, through its company engineers, has been considering plans for the erection of a giant power plant near Philadelphia, in anticipation of the comprehensive program for electrification of its lines.

It is understood that the railroad's reported statement, emphasizing the demand for large amounts of 25-cycle electrical energy among other Philadelphia public utilities, mentioned conferences held between Pennsylvania officials and others heading companies in the public utility field.

The plant said to be under consideration would be built on the Delaware River, near Trenton, N. J., at a cost estimated at more than $10,000,000.

According to the report, the Philadelphia Electric Co., which now supplies power for the other utility companies, issued a denial that its representatives had ever attended such a conference. In contradiction of the railroad's contention, officials of the electric company, it was rumored, declared its new Port Richmond plant and the Conowingo project now under consideration could supply every power requirement in Philadelphia and vicinity.

Court Rules Worthington Patents Infringed

Having pended in the District Court of the United States at Buffalo, N. Y., the suit brought by the Worthington Pump & Machinery Corp., against Clark Brothers Co., of Olean, New York, for infringement of the Worthington patents, Reissue No. 13,991, granted Oct. 12, 1915, and No. 1,341,-145, granted May 25, 1920, on its well-known feather valves, by the valves used in the compressors put out by Clark Brothers Co., has been decided in favor of Worthington by Judge Hazel.

A decree has been entered holding both patents valid and infringed by Clark Brothers Co.'s valves, and ordering an injunction and accounting against Clark Brothers Co.

Under Judge Hazel's decision, the Worthington Pump & Machinery Corp. has the exclusive right to the use of strip valves which bend on a uniform curve in opening, even though attached to the valve seat as in Clark Brothers Co.'s valve.

Swartwout Co. Purchases S. C. Regulator Concern

An announcement of interest to power-plant builders and operators, as well as to industrial leaders throughout the country, was recently issued by the Swartwout Co., 18511 Euclid Ave., Cleveland, Ohio, outlining its consolidation with the "S-C" Regulator Manufacturing Co., Fostoria, Ohio.

D. K. Swartwout, president of the company, continues as chief executive of the merged company, while J. M. Barrett, executive head of the Fostoria firm, becomes a vice-president. D. K. Swartwout, Jr., also continues in an executive capacity, being vice-president and general manager. W. E. Clement is secretary and treasurer, and L. P. Russon, assistant sales manager.

Headquarters of the new company are to be in Cleveland at the factory address, 18511 Euclid Ave. The Fostoria plant of the "S-C" Regulator Manufacturing Co. is to be discontinued, the equipment being moved to the factory buildings of the Swartwout Co. in Orrville, Ohio.

The "S-C" line, developed over twenty years, includes pump governors for every type of work, feed-water regulators, valves for special regulating, differential pressure, high-pressure relief and differentials for electrically driven boiler-feed pumps, and in addition, special drainage control systems. All products are to be distributed under the trade marked brand "Swartwout and 'S-C.'"

No little interest centers around this merger, according to manufacturers in allied industries.

Bill Urges Greater Scope for Ohio Boiler Inspection Law

Amendments to the Ohio boiler inspection law have been introduced by Senator Rebman Jr., of Cincinnati, Ohio.

The present proposal, known as Senate Bill 114, provides for compulsory inspection of boilers used for agricultural purposes, boilers used in the construction of and repairs to railroads and bridges, and boilers used for steaming, heating and drilling of water gas and oil in the open fields.

Boilers in these classes were heretofore specifically exempt from inspection by law. This amendment further provides for inspection of all unfired pressure vessels, except vessels of less than 5 cu.ft. in contents and vessels carrying liquids whose boiling at atmospheric pressure is above 100 deg. F., and vessels subject to temperatures in excess of 750 deg. F.

All other vessels are to be shop inspected during construction, and regularly inspected annually while in operation.

Research Activities Conducted at Purdue University

Activities at Purdue University, financed by the American Railway Association, were outlined recently by Dean A. A. Potter to a member of *Power's* editorial staff.

From March 1, 1925, to Dec. 30, 1926, $382,000 was expended on air-brake research. For the year 1927, $255,000 has been appropriated for research of air brakes, and $15,000 for research on draft gears. In addition to that, $21,000 will be spent for the construction of a special ARA building with an additional $30,000 or more for a special testing machine designed to drop a load of 27,000 lb. suddenly upon a draft gear. Moreover, $6,000 has been appropriated for the purchase of draft gears.

Sixty-five technically trained engineers are engaged in engineering research work alone. This was the minimum number during the last year and a half. At times several more have been engaged, besides a number of non-technically trained helpers.

The Indiana Limestone Co. has appropriated during the last three years over $12,000 to discover what discolors limestone, how to prevent it and how to correct it. This has been accomplished, and the results are entirely satisfactory. The Limestone Association is continuing the support of research.

Other investigations are being carried on in co-operation with manufacturers, public utilities, and the United States Bureau of Public Roads; also, Purdue University is devoting about $25,000 a year from the engineering budget for the administration of the co-operative projects and for the support of investigations which do not lend themselves to co-operative undertakings.

Chicago Consulting Engineers Elect Officers for 1927

At a recent meeting the Chicago Association of Consulting Engineers elected as officers for the ensuing year Irving E. Brooke, president; Ernest V. Lippe, vice-president, and Rollo E. Gilmore, secretary-treasurer.

This body meets regularly on the third Monday of each month at the City Club, 315 Plymouth Court, Chicago. After dinner a regular business meeting is held. Usually, at alternate meetings, well-known speaker are on the program, giving talks on the various technical problems confronting the members in their daily activities.

The membership is limited to mechanical, electrical and sanitary engineers who are not less than thirty-two years of age, and who have engaged in the practice of consulting for a period of not less than ten years and are not connected in any way with the sale of mechanical equipment.

Course in Steam Turbines Open in Detroit

Preliminary to a course in steam turbines, which will be conducted at the University of Michigan by Prof. John E. Emswiler, the first meeting of the class was held in Detroit, Feb. 17.

Instruction is open to any person interested, upon the receipt of the nominal fee. It is expected that a large group of technical and operating engineers will take the course.

B. N. Broido, Noted Superheater Designer, Dead

Benjamin Nikolas Broido, chief engineer of the industrial department of the Superheater Co., of New York and Chicago, died suddenly at his home in New York, Feb. 10. Mr. Broido was known throughout this country and abroad as a designer of exceptional ability of steam superheaters and heat exchange apparatus.

Mr. Broido was born in Wilna, Russia, in January, 1879. His early education was obtained in Germany, and he was graduated in 1904 from Frederick's Polytechnic, Gothen, Germany, with a degree in mechanical engineering. For the next two years he was an instructor at the Polytechnic.

Benjamin N. Broido

From 1906 to 1912, Mr. Broido was connected with Aschersleben Maschinenbau A.G., Aschersleban, Germany. Realizing that in order to design superheaters properly, he must first be thoroughly familiar with stokers and boilers, he next became connected with Hannoversche Maschinenbau A.G., Hannover, Germany, where he developed a new design of Stirling boilers to suit them better to conditions in that country.

Mr. Broido came to this country in 1914 and took a post-graduate course in the City College of New York and Columbia University. Later he became connected with the Roessler & Hasslacher Chemical Co., Perth Amboy, N. J., for which he designed power plants. In 1917 he was engaged by the Philadelphia & Reading Railway Co. to design a power and creosoting plant. At the end of 1917 he became connected with the Superheater Company as designing engineer in charge of design and development of Elesco superheaters for stationary boilers.

As a member of the American Society of Mechanical Engineers he took an active part in steam power plant work. He delivered the following papers at various meetings of the society: "High Temperature and High Pressure Steam Lines," "Radiation in Boiler Furnaces," and "Mechanical Engineering in the Cracking, Heating and Cooling of Oil."

In the last nine years Mr. Broido filed over 75 patent applications in this country and abroad for boilers, superheaters, economizers, heat exchangers, pipe stills, etc. He contributed a number of articles to the engineering press, especially to *Power*.

Mr. Broido was a member of Verein Deutscher Ingenieure, the Engineers Club of Philadelphia and Raritan Lodge No. 61, F. & A. M.

He was unmarried.

Novel Automatic Substation Installed in Canada

A new power plant, which is the first automatic mercury-arc rectifier sub-station in Canada, was recently put in operation at Verdun, Quebec, by the Montreal Tramways Co. The plant has been installed by the company in order to effect material improvement in its power distribution system and to provide sufficient power to handle the transportation facilities necessary to cope with the needs of the city of Verdun as well as various suburbs of the city of Montreal.

The station is fully automatic, no attendants being necessary to keep the plant in operation. Inside the building one of the walls is lined with two lines of high tension circuit breakers. Down the center of the floor are two air-cooled transformers, each connected with two water-cooled rectifiers of a capacity of 600 kw. The station has a high tension capacity of 12,600 volts which is converted by these transformers and rectifiers into a D.C. current at 600 volts tension. A cement base has been laid in the station for installation of another transformer and its accompanying pair of rectifiers.

The cost of the sub-station and equipment amounts to approximately $200,000. The electrical equipment was purchased from the Brown-Boveri Company of Baden, Switzerland.

Hartford N.A.S.E. Section Attend Dinner

Many operating engineers and their friends came from various parts of Connecticut to attend a banquet held by the Hartford Section of the N.A.S.E. Jan. 29.

The speaker of the evening was J. Edwin Brainard, acting governor of Connecticut. The guests of honor included John Quincy Adams, national president, and Sarrett M. Burgess, past national president, each of whom made a short address.

Hartford N.A.S.E. men, the A.S.M.E. and the Hartford Engineers Club are planning a combined smoker and entertainment the last week in April, the date for which has not yet been determined.

Southeastern Power's Output Shows 17 Per Cent Growth

The Southeastern Power and Light Co. reports output of 185,952,685 kw.-hr. in January, an increase of 17 per cent over the 159,369,716 in January, 1926.

Complete Boiler House Shown at British Industries Fair

Central exhibits for this year's steam power section of the British Industries Fair, being held at London and Birmingham from Feb. 21 to March 4, comprise a boiler house and an engine room both of which are technical and full scale.

The boiler house includes a water tube boiler equipped for powdered fuel firing and a Lancashire boiler with mechanical stokers, both exhibits being as complete as conditions allow with complementary equipment such as superheaters, economizers, pumps, fans, water softening plant and various control instruments. The engine room includes two turbines, two reciprocating sets and accessories such as condensing plant, water cooling tower, transformer and sundry indicating and recording instruments.

Of particular interest to American engineers will be the various devices employed in this section for the purpose of smoke abatement; in connection with this problem it is said that no more representative or complete display has ever appeared.

In organizing the joint exhibit, duplication of the various items shown has been avoided as far as possible in order that visitors to the Fair may be able to inspect alternative types of plant. Thus of the two turbines one is direct coupled to an alternating current dynamo while the other is of the back geared type for direct current. Similarly one reciprocating set is shown with a rope drive and the second driving a dynamo. Plans for a similar exhibit are already being considered for 1928 and it is hoped not only that a much larger display may be organized but that the idea may be considerably extended in scope.

Further information and personal invitations can be obtained from the British Consulate General in Chicago.

Cincinnati N.A.S.E. Men Plan Annual Banquet

Members of the Combined Associations of the National Association of Stationary Engineers of Cincinnati, Ohio, will give their fifth annual banquet and dance at the Hotel Alms, Feb. 23.

John Quincy Adams, national president, Fred W. Raven, national secretary, Sarrett Burgess, Past National President, Egbert Douglas, chairman of the power plant cost committee, and J. A. Kerley, Past National President are listed among the speakers. Prominent Cincinnati leaders will lend their support with brief addresses. The radio program will be broadcasted from 8 to 9 P.M. (Eastern standard time) by the Kodel Radio Corp. from Station W.K.R.C., 422 meters.

Eastern Texas Electric Buys Nebraska Electric Power

The Eastern Texas Electric Co. of Delaware, a subsidiary of the Engineers Public Service Co., has purchased the Nebraska Electric Power Co., which serves some twenty-five towns in central and northwestern Nebraska and maintains power stations in Loup City, Broken Bow, Cozad, and Lexington.

The Nebraska Electric Power Co. will be under the executive management of Stone & Webster, Inc., and will be operated from Scottsbluff, Nebraska.

English Firm Supplies Valves for New Zealand Project

Penstock value equipment for two 25,000-hp. waterwheels to be constructed for the government of New Zealand will be supplied by J. Blakeborough & Sons, Ltd., valve specialists, Brighouse, England.

The turbines and equipment are scheduled for what is known as the Waikaremoana hydro-electric power development undertaken by the government of New Zealand.

These valves are to be of the Larner-Johnson type with cast-steel bodies, the inlet diameter being 66 in., for a 645-ft. head. Each valve will be fitted with three forms of control—manual, electric automatic and remote, the last being by means of push buttons mounted on the main switchboard. Should emergency conditions arise such as a turbine runaway or burst casing, the automatic gear will come into operation, and close the valve in 60 seconds. As a reserve, in case of failure of the current to the operating motor, hand gear is provided which gives control of the valve from the turbine-house floor.

Engineers Adopt the Dole!

Unemployment insurance for professional engineers will soon be a fact.

According to an announcement issued by M. E. McIver, secretary of the American Association of Engineers, plans have been completed by that body for the relief of those active members of the calling unengaged. The statement makes known that "the American Association of Engineers will presently arrange to cause this insurance to be written."

Six Condensers in Building for Crawford Avenue

Six radial-flow, single-pass, vertical-type condensers, totaling 90,000 sq.ft., and auxiliaries will be installed at the Crawford Avenue station of the Commonwealth Edison Co., Chicago, Ill., to serve the three-cylinder 104,000-kw. steam turbine which the Westinghouse Electric & Manufacturing Co. is building at the South Philadelphia works.

Westinghouse has secured the contract to supply the condensers.

Issues Specifications for Testing Materials

Pending specifications recently issued by the American Society for Testing Materials cover alloy-steel bolting material, carbon-steel castings for valves, flanges, and fittings, forged or rolled steel pipe flanges and lap-welded and seamless steel pipe, all for high-temperature service.

Obituary

David Cady Davis, special patent attorney for the Westinghouse Electric & Manufacturing Co., located at the Bloomfield works, of the Westinghouse Lamp Co., died in the Mountainside Hospital, Montclair, New Jersey, Jan. 22, as the result of an operation. Mr. Davis, who was 41 years of age, had been associated with the Westinghouse company since 1914. One year ago he was promoted to the position of special patent attorney for the Westinghouse company, with offices at the Bloomfield Works.

George B. Preston, consulting engineer on power-plant design and operation for E. L. Phillips & Co., engineers, 50 Church St., New York City, and life member of the American Society of Mechanical Engineers, died at his home, 200 Sylvan Ave., Leonia, N. J., Feb. 9. He was an instructor in mechanical engineering at Sibley College, Cornell University, from 1888 to 1899, where he was graduated in 1888. He then became inspector of steam boilers and marine engines for New York State. In 1903 he served as mechanical engineer in power-plant design for Westinghouse Church & Kerr, becoming, in 1912, instructor in steam engineering at Columbia University. His death terminated his four-year association with E. L. Phillips & Co.

Personal Mention

W. C. Stettinius, president of the American Hammered Piston Ring Co. of Baltimore, Md., has been appointed a member of the merchandising committee of the Automotive Equipment Association, filling the vacancy caused by the resignation of T. H. Quinn of the National Lamp Works of the General Electric Co.

P. H. Dater, district engineer for the U. S. Forest Service at Portland, Ore., has been called to Washington to confer with the staff of the Federal Power Commission in connection with the Skagit River development and other power projects on forest lands.

E. B. Newill has been appointed manager of the control engineering department of the Westinghouse Electric & Manufacturing Co., according to a recent announcement. Mr. Newill, a graduate of the Georgia Institute of Technology, joined the company twelve years ago.

H. W. Brooks, formerly fuel engineer with the Bureau of Mines and later with the Fuller Lehigh Co., has joined the Erie City Iron Works in the capacity of consulting engineer.

R. R. Row, advisory and sales engineer, 50 Church St., New York City, has been appointed as research and sales engineer on corrosion resisting, high strength metals, under special arrangements, by the American Brass Co., in promoting the sales of "Everdur." Mr. Row has also taken up an account as advisory sales engineer with Charles Proescher, Inc.

H. D. James, who has been continuously associated with the Westinghouse Electric & Manufacturing Co. since 1904, has been promoted to the position of consulting control engineer in the engineering department of the company.

S. M. Finn has been appointed by the Drake Non-Clinkering Furnace Block Co., Inc., as general manager of the company. Mr. Finn has long been identified with steam power plant work and was at one time assistant chief engineer of the American Engineering Co.

Society Affairs

The Philadelphia Section of the A.S.M.E. will hold a meeting in the Drexel Institute Auditorium, 32nd and Chestnut Sts., the evening of Feb. 25. There will be a debate, "Resolved that coal can be burned in powdered form more advantageously than in any other way," between teams from the student branches of the University of Pennsylvania and Drexel Institute.

The New York Section of the American Society of Refrigerating Engineers will hold its next meeting Wednesday evening, Feb. 23, at the Machinery Club, 50 Church Street, New York City. "Interesting Phases of New York City's Water Supply" will be presented by William W. Brush, chief engineer of the Department of Water Supply, Gas and Electricity of the City of New York.

Business Notes

The Chain Belt Co., Milwaukee, Wis., and the **Stearns Conveyor Co.**, Cleveland, Ohio, announce the change of address of their Pittsburgh office to 704 Magee Bldg., 336 Fourth Avenue, Pittsburgh, Pa.

The Sangamo Electric Co. announces the appointment of Reginald Mortimer Campbell as eastern district manager in charge of watt-hour and ampere-hour meters and electric clock sales. Mr. Campbell has been associated with the electrical industry for the last twenty years.

The Blaw-Knox Co. announces an addition to its engineering and selling force in the person of John C. White, president of the Arrowhead Iron Works of Pennsylvania, Inc. Mr. White has recently joined the organization of the Blaw-Knox Co. and has been appointed sales manager of the steel grating and flooring department. He will be located at the general offices of the Blaw-Knox Co. at Pittsburgh.

The Hill Clutch Machine & Foundry Co., Cleveland, Ohio, recently appointed Charles C. Phelps, 473 Getty Ave., Paterson, N. J., as sales engineer for the metropolitan, New York and northern New Jersey district. The manufacture of the Hill Clutch Machine & Foundry Co. includes everything for power transmission such as shafting, couplings, bearings, clutches, pulleys, sheaves, belt tighteners, speed transformers, agitators, gears and sprockets.

Coming Conventions

American Institute of Electrical Engineers. F. L. Hutchinson, secretary, 33 West 39th St., New York City. Kansas City, Mo. regional meeting March 17-18, Bethlehem, Pa. regional meeting April 21-23, Pittsfield, Mass. regional meeting May 25-27. Summer convention at Detroit, Mich., June 20-24 inclusive; Pacific Coast convention at Del Monte, Calif., Sept. 13-16.

American Oil Burner Association. Annual convention and exposition at Buffalo, N. Y., April 5-7, inclusive; C. F. Olmstead, 350 Madison Ave., New York City.

American Refractories Institute. Annual meeting probably in April; D. A. Texter, secretary, 2202 Oliver Bldg., Pittsburgh, Pa.

American Society of Civil Engineers. George T. Seabury, secretary; Spring convention at Asheville, N. C., April 20-22. Annual convention at Denver, Col. July 13-15.

American Society of Mechanical Engineers. Spring meeting at White Sulphur Springs, W. Va., May 23-26. Calvin W. Rice, secretary. Midwest regional meeting will be held in Kansas City, April 4-6 inclusive; F. S. Dewey, chairman of the Kansas City Section.

American Water Works Association. W. M. Niesley, assistant secretary, 170 Broadway, N. Y. Annual convention Hotel Sherman, Chicago, June 6-11.

American Welding Society. Annual meeting at 29 West 39th St., New York City, April 27-28-29.

Association of Iron and Steel Electrical Engineers. Annual convention in conjunction with Iron and steel exposition at Pittsburgh, Pa., June 13-18, inclusive.

Heating and Ventilating Exposition. Will be held at Twelfth Regiment Armory, New York City, March 14-19 inclusive.

National Association of Practical Refrigerating Engineers. Annual convention probably in November; E. H. Fox, 5707 W. Lake St., Chicago, Ill.

National Association of Stationary Engineers—Annual convention, in conjunction with the Pacific Coast Power Show, will be held at the Ambassador Hotel, Los Angeles, Calif., Aug. 22-27 inclusive, John Topman, secretary, convention committee, Ohio State annual convention in Memorial Hall, Lima, Ohio, June 16-18, inclusive, in conjunction with the Northwestern Ohio Power Show; P. H. Grigsby, secretary of convention committee, Lima, Ohio. New England States convention at Portland, Me., June 17-18. Thomas H. Clark, president, Worcester, Mass.; Robert Johnson, secretary, 65 Charlotte St., Worcester, Mass. Indiana State convention at Anderson, May 27-28; George S. Billman, secretary.

National Board of Boiler and Pressure Vessel Inspectors. Annual meeting at Nashville, Tenn., during second week of June.

National Electric Light Association. A. Jackson Marshall, secretary, 29 West 39th St., New York City. Annual convention at Atlantic City, week beginning June 6.

Universal Craftsmen Council of Engineers. Thomas H. Jones, secretary, 33 Linden Ave., Cherrydale, Va. Annual convention at Buffalo, N. Y. Aug. 2-6.

The Railway & Industrial Engineering Co. of Greensburg, Pa., affiliated with the American Brown Boveri Electric Corp., has been awarded a contract for all switching equipment and steel work for the 154,000 super-power outdoor substation of the Public Service Gas & Electric Co. at Marion, N. J.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run except Pittsburgh gas slack:

Bituminous Net Tons	Market Quoting	Feb. 14 1927
Pool 1	New York	$3.00@$3.25
Smokeless	Boston	2.06
Clearfield	Boston	1.85@ 2.10
Somerset	Boston	2.00@ 2.25
Kanawha	Columbus	1.40@ 1.75
Hocking	Columbus	1.75@ 2.00
Pittsburgh	Pittsburgh	1.80@ 1.90
Pittsburgh gas slack	Pittsburgh	1.40@ 1.50
Franklin, Ill.	Chicago	2.50@ 2.75
Central, Ill.	Chicago	2.00@ 2.25
Ind. 4th Vein	Chicago	2.25@ 2.50
West Ky.	Louisville	1.35@ 1.65
S. E. Ky.	Louisville	1.60@ 2.00
Big Seam	Birmingham	1.50@ 2.00
Anthracite Gross Tons		
Buckwheat No. 1.	New York	3.00@ 4.25
Buckwheat No. 1.	Philadelphia	2.50@ 4.50
Birdseye	New York	1.60@ 2.00

FUEL OIL

New York—Feb. 17, light oil, tank-car lots; 28@34 deg. Baumé, 5¾c. per gal.; 36@40 deg., 6¼c. per gal. f.o.b. Bayonne, N. J.

St. Louis—Feb. 9, tank-car lots, f.o.b. St. Louis; 24@26 deg., $2.02 per bbl.; 26@28 deg., $2.07 per bbl.; 28@30 deg., $2.12 per bbl.; 30@32 deg., $2.17 per bbl.; 32@36 deg., gas oil, 6.23c. per gal.; 38@40 deg., 6.98c. per gal.

Pittsburgh—Feb. 8, f.o.b. local refinery; 30@34 deg., fuel oil, 6¾c. per gal.; 36@40 deg., fuel oil, 7c. per gal.

Philadelphia—Feb. 8, 27@30 deg., $2.52@$2.58 per bbl.; 13@19 deg., $1.90@$1.96 per bbl.

Cincinnati—Feb. 14, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 6½c. per gal.; 26@30 deg., 6⅝c. per gal.; 30@32 deg., 7c. per gal.

Chicago—Feb. 7, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 92c. per bbl.; 24@26 deg., $1.27½ per bbl.; 26@30 deg., $1.35; 30@32 deg., $1.75.

Boston—Feb. 14, tank-car lots, f.o.b. 12@14 deg. Baumé, 4.8c. per gal.; 28@32 deg., 6c. per gal.

Dallas—Feb. 12, f.o.b. local refinery, 26@30 deg., $1.75 per bbl.

The Chicago Pneumatic Tool Co., 6 East 44th St., New York City, has closed its own offices in Dallas and Houston, Tex., incident to the appointment of Whealton & Townsend, Inc., with main offices at 120 East Brady St., Tulsa, Okla., as distributors of Chicago Pneumatic products in the State of Texas east of Meridian 102. Whealton & Townsend, Inc., will maintain sales and service offices in both Dallas and Houston and will establish additional offices elsewhere when conditions warrant.

Trade Catalogs

Piston Valves. — The Schutte & Koerting Co., Philadelphia, Pa., has issued bulletin No. 8-T which illustrates and describes the piston valves (Klinger patents) manufactured by the company.

Catalog of American Industry and Trade.—The Amtorg Trading Corp., 165 Broadway, New York City, has issued in the Russian language a most elaborate commercial compendium of the United States prepared for distribution among business and trade executives and all important purchasing agents, technical men and professors of the Soviet Union. The heavy volume of 1,076 large pages, 9x12 in., with 2,800 illustrations, appears coincidental with the completion of two years of American-Soviet trade. The volume's 643 pages of American advertising contain the insertions of 382 manufacturers of 30 states of the Union and of Canada. Virtually every important American manufacturing corporation is represented in the pages. Following the advertising section is a complete index of 155 pages, alphabetically listing American manufacturing products with the makers of each. Seven thousand products are listed in the index, with 45,000 firms and corporations. A section of the volume is devoted to 28 articles by leading American technical experts setting forth various phases of American technical and manufacturing development.

New Plant Construction

Ark., Nashville—Southern Ice & Utilities Co., Sante Fe Bldg., Dallas, Tex., awarded contract for the construction of a 70 ton ice and cold storage plant including engine room, etc. here, to E. M. Sproul Construction Co., Strauss Bldg., Chicago, Ill. Estimated cost $190,000. Contract for machinery awarded.

Calif., Burbank—City plans waterworks improvements including pumping plants, reservoirs, etc. Estimated cost $150,000. T. R. Mini, is engineer.

Calif., Santa Monica—Miramar Hotel Co., awarded contract for the construction of a 10 story hotel including power plant, on Ocean Ave., to Scofield Engineering & Construction Co., Pacific Finance Bldg., Los Angeles. Estimated cost $1,250,000. Steam heating, refrigeration and ventilation systems, elevators, etc., will be installed.

Calif., Santa Monica—Mutual Shares Property Inc., 221 Santa Monica Blvd., is having plans prepared for the construction of a 12 story office and stores building including steam heating system, elevators, etc. at Third St. and Santa Monica Blvd. Estimated cost $750,000. M. E. Durfee, 221 Commercial Exchange Bldg., is architect.

Calif., Van Nuys — Glendale Creamery Co., 755 West Doran St., plans the construction of a pasteurizing and refrigeration plant. Estimated cost $50,000.

Conn., Hartford—Hartford Electric Light Co., T. H. Soren, V. Pres., is having plans prepared for the construction of addition to plant including mercury boilers, etc. at 80 South Meadow St. Stone & Webster Inc., 80 Federal St., Boston, Mass., is architect and engineer.

Ill., Chicago—Allerton Club, W. H. Silk, Gen. Mgr., 710 North Michigan Ave., is having plans prepared for the construction of a club building including steam heating system, elevators, etc. at Huron St. and Clair Ave. Estimated cost $1,500,000. Murgatroyd & Ogden, 369 Lexington Ave., New York, N. Y., are architects.

Ill., Chicago—C. W. Morris, 111 West Washington St., is having plans prepared for the construction of a 17 story apartment including steam heating system at Stone and Division Sts. Estimated cost $700,000. Hooper & Janusch, 879 North State St., are architects.

Ill., Chicago—McNally & Quinn, 8 South La Salle St., Archts., is having plans prepared for the construction of a 15 or 17 story apartment including electric refrigeration system, elevators, etc., at 70th Pl. and South Shore Dr. Estimated cost $2,000,000. Owners name withheld.

Ia., Iowa City—City plans waterworks improvements including 400,000 gal. reservoir, high and low pressure pumps, etc. Estimated cost $75,000.

Ia., Sioux City—Frances Building Co., A. Sanford, Pres., 307 Frances Bldg., will readvertise for bids for the construction of a 4 and 7 story theatre and office building at 6th and Pierce Sts. Estimated cost $1,500,000. C. W. & G. L. Rapp, State Lake Bldg., Chicago, Ill., are architects.

Ia., Lake Charles—Local Syndicate, c/o T. S. McCook, Frank Bldg., Archt., is having preliminary plans prepared for the construction of a 7 story hotel including steam heating system, high speed electric elevators, etc. Estimated cost $600,000.

Md., Baltimore—Crosse & Blackwell, c/o Clark, MacMullen & Riley, 101 Park Ave., New York, N. Y., Engrs., awarded contract for the construction of a power plant at Eastern Ave. and 42nd St., here., to M. A. Long Co., 10 West Chase St., Baltimore, Md. Estimated cost $400,000.

Md., Vienna—Eastern Shore Gas & Electric Co., Salisbury, Md., subsidiary of the National Public Service Corp., 165 Broadway, New York, N. Y., plans the construction of a 16,000 hp. turbine station here. Estimated cost $2,000,000. Private plans.

Mass., Boston—M. C. Burton, 1 Federal St., is having sketches made for the construction of a 15 story office and loft building on Broad St. Estimated cost $1,500,000. Blackall, Clapp & Whittemore, 31 West St., are architects.

Mass., Boston—John Hancock Mutual Life Insurance Co., W. L. Crocker, Pres., 197 Clarendon St., awarded contract for the construction of a 4 story addition to office building at Clarendon, Stuart and St. James Aves. to L. P. Soule & Son Co., 80 Boylston St. Estimated cost $1,000,000.

Mass., Boston—Massachusetts General Hospital, Fruit St., is having plans prepared for the construction of an 11 story hospital. Estimated cost $1,000,000. Coolidge, Shepley, Bullinch & Abbott, Ames Bldg., are architects.

Mass., Salem—Salem Electric Co., c/o C. H. Tenney & Co., 200 Devonshire St., Boston, Engrs., awarded contract for the construction of addition to switchboard building to L. R. Porter Co., 6 New Derby St. Estimated cost $40,000.

Mich., St. Joseph—Hotel Whitcomb, is having preliminary sketches made for the construction of a hotel at Lake Blvd. and Ship St. Estimated cost $600,000. Pond, Pond, Martin & Lloyd, 6 North Michigan Ave., Chicago, Ill., are architects.

Minn., Minneapolis—Gateway Bldg. Co., W. Weisman, Pres., 600 Temple Ct., plans the construction of a 3 or 4 story hotel and office building at 13th St. and Harmon Pl. Estimated cost $600,000. Architect not selected.

Minn., Thief River Falls — City, P. S. Pederson, Clk., will receive bids until Feb. 24 for rebuilding power plant, to double present capacity of 350 hp. Estimated cost $80,000. Jacobson Engineering Co., 430 Oak Grove St., Minneapolis, is engineer.

Miss., Hattiesburg—Chicago Syndicate, c/o Hattiesburg Chamber of Commerce, T. S. Jackson, Secy., is having preliminary plans prepared for the construction of a 7 story hotel and theatre building. Estimated cost $700,000.

Missouri—The Kansas City Power & Light Co., 14th St. and Grand Ave., Kansas City, plans the construction of a hydroelectric plant in southern Missouri. Estimated cost $20,000,000. Private plans.

Mo., Clinton — Missouri Public Service Co. has acquired the plant of the West Missouri Power Co. and plans the construction of addition to power plant and installation of equipment to double the capacity, also transmission line from Clinton to Pleasant Hill. Estimated cost $852,000. Private plans.

Mo., St. Louis—Syndicate, c/o W. H. Gruen, 1510 Chestnut St. Archt., is having preliminary plans prepared for the construction of a 25 and 40 story office and stores building including steam heating system, etc. Estimated cost $2,500,000.

Neb., Beatrice—City is having preliminary plans prepared for waterworks improvements including pumping equipment, 2,000,000 gal. storage reservoir, etc. C. E. Thornburgh, City Hall, is engineer.

Neb., Palisade—T. C. Krotter, plans the construction of a hydro-electric power plant and dam, 90 ft. high, 500 to 1,000 ft. long. Estimated cost $44,000. Private plans.

N. J., Highland Park—St. Peters General Hospital, J. W. Morris, 94 Somerset St., New Brunswick, will soon award contract for the construction of a 5 story hospital here. Estimated cost $900,000. Maginnis & Walsh, 100 Boylston St., Boston, Mass., are architects.

N. J., Montclair—Glen Ridge Hospital, is having preliminary plans prepared for the construction of a nurses' home including steam heating system. Estimated cost $500,000. York & Sawyer, 100 East 42nd St., New York, N. Y. are architects.

N. Y., Albany—Albany Port District Comn., plans the construction of first unit to cold and dry storage warehouse. Estimated cost $1,500,000.

N. Y., Brooklyn—E. J. Coates, 59 Livingston St., is having plans prepared for the construction of a 5 story office building at 140 Remsen St. Estimated cost $500,000. Slee & Bryson, 154 Montague St., are architects.

N. Y., New York—Sigley Realty Corp., S. & W. Glatzes, 152 West 42nd St., awarded contract for the construction of an office building at West 46th St. to Rhodes & Koppell, 347 Madison Ave. Estimated cost $600,000. Steam heating system, elevators, etc. will be installed.

N. Y., New York—M. Zipkes, 25 West 43rd St., Archt., is preparing plans for the construction of a 16 story office and stores building including steam heating system, elevators, etc., at 222 East 34th St. Estimated cost $800,000. Owner's name withheld.

N. Y., Rochester — Gordon & Koelber, Hiram Silbey Bldg., Archts., will soon receive bids for the construction of a 12 story office and fraternal building including refrigeration and ventilation systems, boilers, swimming pool, elevators, etc., at Chestnut and Lawn Sts., for Knights of Columbus, 700 East Main St. Estimated cost $1,500,000. S. Firestone, 52 South Ave., is engineer.

N. C., Saluda—Mayor & Bd. of Aldermen will receive bids until Feb. 23 for waterworks improvement including impounding dam, pumping station, centrifugal pump, pipe lines, etc. G. C. White, Durham, is engineer.

O., Cleveland—City is having preliminary plans prepared for waterworks improvements including 150,000,000 gal. pumping station and filtration plant, etc. A. L. Quayle, 211 City Hall, is engineer.

O., Chagrin Falls — Bd. of Education, H. B. Pugsley, Clk., will soon award contract for the construction of a central heating plant including boilers, stokers, etc. A. M. Allen & Co., 7016 Euclid Ave., Cleveland, is architect and engineer.

O., Dayton—Dayton Hotel Co., Harries Bldg., awarded contract for the construction of a 16 story hotel at First and Main Sts. to Selden Breck Contracting Co., 320 North 4th St., St. Louis, Mo. Estimated cost $2,000,000.

O., Dayton—Terminal Cold Storage & Ice Co., 20 Eaker St., awarded contract for the construction of an ice and cold storage plant, to John W. Boren & Sons Co., McClure St. Estimated cost $40,000.

O., Dover—Bd. of Control, will receive bids until Mar. 15 for the construction of addition to electric light and power plant. Estimated cost $100,000.

Okla., Bartlesville—City plans to rehabilitate present waterworks plant including pumping equipment, etc. Estimated cost $100,000. Burns & McDonnell Engineering Co., 402 Interstate Bldg., are engineers.

Okla., Caddo—City plans an election Feb. 21 to vote $16,000 for waterworks improvements including triplex pump, mains, etc. J. C. Milliken, Continental Bldg., Oklahoma City, is engineer.

Okla., Ponca City—Ponca City Milling Co. awarded contract for the construction of a 6 story mill including boiler and engine room, etc., to Charles M. Dunning Construction Co., 420½ North Hudson St., Oklahoma City. Estimated cost $51,000.

Okla., Tulsa—Waite Phillips Co., Petroleum Bldg., is having preliminary plans prepared for the construction of a 20 story office building including steam heating system, etc. on 6th St. Estimated cost $1,000,000. Keene & Simpson, 1005 Land Bank Bldg., Kansas City, Mo., are architects.

Pa., Rochester—Guarantee Liquid Measure Co., is receiving bids for the construction of a power house and office building. Estimated cost $150,000. A. Blackstone, c/o owner, is engineer.

Texas—West Texas Utilities Co., San Angelo, is having preliminary plans prepared for the construction of a sub-station at Tankersley, also 90 mi. transmission line from San Angelo to Texon. Private plans. Several sub-stations will be constructed at Mertzen, Sherwood and Barnhart later. Machinery for all plants will be required.

Tex., Brownsville—Catholic Jr. College, c/o J. B. Frigon, had plans prepared for the construction of a junior college including refrigeration and ventilation systems, boilers, elevators, etc. Estimated cost $200,000. Private plans.

Tex., Brownwood — Morgan-Wade Utilities Corp. is having plans prepared for the construction of addition to ice plant, to increase the capacity to 30 ton. Estimated cost $40,000. Private plans. Machinery will be required.

Tex., Midland—Gulf Production Co., controlled by Gulf Oil Corp. of Pennsylvania, Frick Bldg., Pittsburgh, Pa., has acquired a 320 acre site and plans the construction of a pumping station and pipe line, here. Estimated cost $400,000. Machinery will be required.

Tex., Quanah — Southwestern Light & Power Co., is having plans prepared for the construction of a power plant on Lake Pauline near here. Estimated cost $225,000. Private plans. Machinery will be required.

Tex., San Angelo—West Texas Utilities Co., H. Hoppe, Supt., Abilene, will build an addition to steam power plant on Lake Concho near here by day labor. Estimated cost $300,000. Sargent & Lundy, 1412 Edison Bldg., Chicago, Ill., are engineers.

Tex., San Antonio—A. H. Shafer Estate, 418 North St. Marys St., had plans prepared for the construction of a 12 story hotel including circulating ice water system, 2 high speed elevators, etc., at St. Marys and Pecan Sts. Estimated cost $500,000. P. G. Silber & Co., 331 Bedell Bldg. are architects.

Tex., San Antonio — Wood Properties Corp., H. C. Wood, Travis Bldg., will build a 15 story hotel at Navarro and Martin Sts., by day labor. Estimated cost $850,000. Kelwood Co., Travis Bldg., is architect and engineer. Refrigeration and ventilation systems, boilers, elevators, etc., will be installed.

Wash., Longview—Long View Lumber Co., plans extensions and improvements to power plant including 6,000 kw. generator and two boilers to increase the capacity from 18,000 to 24,000 kw. The plant will furnish electricity for Longview, Ryderwood and several other towns in the vicinity.

Ont., Toronto—Chateau Benvenuto Ltd., E. L. Clemens, Pres., 40 Richmond St., W., has acquired a site and plans the construction of a hotel including steam heating and refrigeration systems, elevators, etc. Estimated cost $3,000,000. E. Bird, 63 King St. E., is architect.

Ont., Toronto—Toronto General Hospital, College St., plans the construction of a group of hospital buildings including power house, etc., at College St. and University Ave. Estimated cost $2,500,000. Architect not selected.

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Equipment Wanted

Colo., Denver—Bureau of Reclamation, will receive bids until Mar. 15 for one 3,400 hp. hydraulic turbine, one 3,000 kva. generator, three 1,000 kva. transformers, one 37,000 v. oil circuit breaker, switching equipment and six disconnecting switches, etc. for Guernsey power plant, North Platte project Nebraska-Wyoming.

Fla., Miami—W. S. Meserve, Clyde Court Apts., is in the market for air compressor, jacks, etc.

Ill., Murphysboro—Acme China Co., is in the market for a 100 hp. steam engine direct connected to 100 kw. generator.

Ill., Springfield—George B. Smith Color & Chemical Works, lessee, First National Bank Bldg., is in the market for equipment including two steam boilers, pumps, etc. for proposed new plant to be rebuilt by Wabash Ry. Co., Exchange Bldg., St. Louis, Mo., to replace fire loss. Estimated cost $200,000. R. H. Howard, is chief engineer.

Minn., Thief River Falls — City, P. S. Pederson, Clk., will receive bids until Feb. 24 for complete equipment including two water wheels, flood gates, etc. for power plant.

Mo., Clinton — Missouri Public Service Co. has acquired the plant of the West Missouri Power Co. and plans the installation of equipment for proposed addition to power plant to double the capacity.

Mo., St. Louis—Sternberg Dredging Co., 1706 Arcade Bldg., will receive bids about Mar. 31 for electrically driven dredging equipment, Diesel engine, etc. for proposed dredge boat. Estimated cost $250,000.

N. C., Greenville—Water & Light Comn., M. Swartz, Supt., will receive bids until Mar. 15 for one 750 hp. sectional header water tube boiler and stoker with motor drive and motor driven fan.

N. C., Saluda—Mayor & Bd. of Alderman will receive bids until Feb. 23 for centrifugal pump for proposed waterworks improvements.

O., Columbus—Hamilton-Parker Fuel & Supply Co., D. Sherzer, Pres. & Mgr., is in the market for loading and unloading equipment for proposed new yard for coal, sand and gravel, etc., at Broad St. and Big Four tracks.

O., Dover—Bd. of Control, will receive bids until March 15 for a turbine, two stokers, etc., for proposed addition to electric light and power plant.

Okla., Wewoka—City is having preliminary plans prepared for the installation of a 400 hp. Diesel engine and generator in pumping station. Estimated cost $35,000. Engineer not selected.

Pa., Philadelphia—Dept. of City Transit, H. E. Ehlers, Dir., 1211 Chestnut St., will receive bids until Feb. 23 for heating system and compressed air lines for general repair and inspection shops, two 330 hp. water tube boilers, one auxiliary boiler, vacuum pumps, hot water generator and circulating pump, incinerator, etc. for Broad St. subway.

Tex., Borger (mail Hillsboro) — Panhandle Power & Light Co., Amarillo, plans the installation of a 7,500 kw. turbo generator unit using Stirling boilers and all auxiliaries to increase the capacity to 20,000 kva. for proposed addition to light and power plant here.

Tex., San Angelo—West Texas Utilities Co., H. Hoppe, Supt., Abilene, is in the market for one 5,000 kw. generator, three high pressure boilers, etc., for proposed addition to steam power plant on Lake Concho near here.

Alta., Calgary—Electrical Engineers Ltd., is in the market for one 75 hp. slipring, one 150 hp. squirrel cage and one 150 hp. synchronous type electric motors, 3 ph., 60 cycle, 2,200 v.

Ont., Toronto—City Council plans the installation of a low lift pumping plant including electrically driven centrifugal pumps, etc., in Ashbridges Bay. Estimated cost $525,000. R. C. Harris, City Hall, is engineer.

Que., Three Rivers—City is in the market for a 1,000 g.p.m. automatic pump for proposed tunnel on St. Maurice St. Estimated cost $160,000. Z. Lambert, is engineer.

Portugal, Lisbon—Ilidio Mariz Simoes Eng., Central Tijo, Jungueira, prices and catalogs on refractory products for steam boilers, aluminum wires for electric transmissions, refrigeration plants (tower and duces systems) for condensers.